METALS and ALLOYS

The Engineering Magazine of the Metal Industries

blished Monthly by Reinhold Publishing Corporan, East Stroudsburg, Pa., U.S.A. Ralph Reinhold, esident and Treasurer; H. Burton Lowe, Vice esident and Secretary; Philip H. Hubbard, Vice esident; Francis M. Turner, Vice President; Wilm P. Winsor, Vice President; G. E. Cochran, Vice esident. Executive and Editorial Offices, 330 West d St., New York. Price 25 cents a copy. Annual bscription: U. S., Possessions and Canada, $2.00. Other Countries, $3.00. (Remit by New York aft.)

Entered as second class tter June 12, 1934, at the Post Office at East oudsburg, Pa., under the Act of March 3, 1879.

VOLUME 18 · NUMBER 2 · AUGUST, 1943

This Month

ENGINEERING FILE FACTS

Every Month

Metallurgical Engineering Digest

The Production Front

by Harold A. Knight
News Editor

We're satisfied over our production in actual test as the parent whose Willie washes behind his ears. . . . Our slow but rugged battleships outpunch the swift but fragile enemy. . . . Our enemies probably have the equivalent of strikes, race riots and Washington muddling.

Steel pace recovers fast after coal strike. . . . Yet tired mills may break down simultaneously. . . . We've recovered 150,000 tons of steel in the "Share" campaign. . . . If we lack steel, what about the Japs? . . . We see two straws in the wind. . . . Need for full production for 12 months seen, including occupation equipment.

Army calls more metals critical than do civilians. . . . We cartoonize the riveting girl—God bless 'er! . . . Do "stitched" metals hold water (or gasoline)? . . . You, citizens, own an $89,000 share in our nation's assets. . . . Who was wacky—the banker or we? . . . What about synthetic rubber?

The Child Who Develops Correctly

Probably there is no more profound and basic satisfaction than that of hard-working parents who are realizing that their children are fulfilling the old adage that "as the twig is bent, the tree will grow." William, often the problem child, stands among the six highest in the high school graduation class, and has received a scholarship in the leading technical college.

So do the American people now watch and regard the results of our war production as our enemies are shattered on every front. Our airplanes are shooting down enemy aircraft at a ratio most flatteringly in our favor. Our naval designers are proving that our slower but more rugged battleships, cruisers and destroyers are superior to lighter and, perhaps, speedier enemy vessels. Our guns can hold their own with the best. Our tanks can meet successfully the biggest brutes that Germany turns out.

Rationing Is Easier to Bear

In short, our sacrifices have been worth while and make more bearable the stricter sacrifices necessary before the wars are over. We are having success in the face of many unexpected disappointments at home, such as coal strikes, race riots, bickerings at Washington, and politics where politics are entirely out of place.

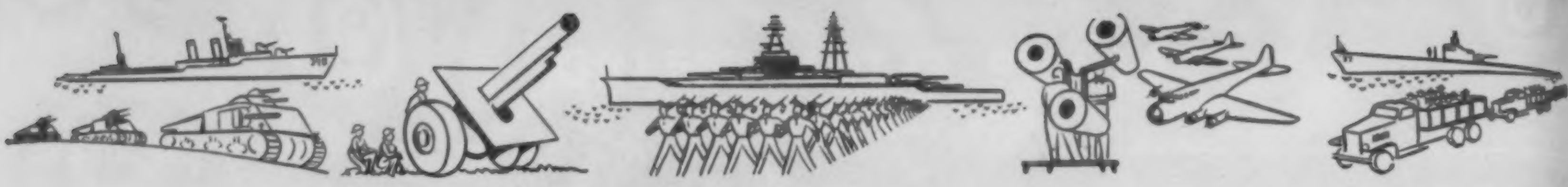
There may be a consoling thought in that probably our enemies have equal or more serious inconsistencies and failures in human relations than we, but strict censorship prevents our hearing of them. At least public opinion in this country has always been powerful in correcting evils—look how we abolished slavery! But who is there to correct the many fantastically false moves of an Adolf Schickelgruber?—nobody but Hitler himself!

Just as all roads (and many bombings) lead to Rome, just so do all supply roads in our war production lead back to steel. The coal strike brought the sharpest recession in steel production since Pearl Harbor, causing profoundest disgust among even those who had only an elementary knowledge of the industrial picture. Yet by July 19 the pace was back to 98.3 per cent. Truly a resilient industry.

There is always danger, however, that steel mills will break down like the "One Hoss Shay," because of the many months of strain at unprecedentedly high production. Furnace linings, bearings, rolls and hundreds of other contact points are vulnerable.

"Share the Steel"

The latest plan to bring out more



available steel is the "Share the Steel" campaign, which had netted over 150,000 tons of steel by mid-July. The campaign provides that all consumers cancel third- and fourth-quarter orders for steel products of which they have large inventories in relation to current consumption. A force of more than 400 representatives of WPB is visiting steel consumers in this campaign.

As scarce as our steel may seem, we surely must have a great plethora by comparison with other nations, particularly our enemies. Take the matter of our steel airplane landing mats for "pocket airfields." The head of the Irving Subway Grating Co., Long Island City, suggests that the Nipponese have been unable to take advantage of bases in the Aleutians because they could not spare steel for such mesh. We found in Attu that they had been unable to provide suitable surfaces for bombers.

Washington plans for peak war-goods output in 1944, though recently we have been falling behind planned schedules. Over-all production in both May and June had been deficient.

We See Two Things

When a farmer wishes to ascertain weather of tomorrow he wets a finger with saliva, holds it up into the air and determines which side of his finger dries first—from that direction the wind is coming. So, we wet our finger and try to ascertain the trends in industry during the month.

We are impressed with two things from our news coverages of the month. In our news columns are recorded two instances where manufacturing companies are hiring women 100 per cent, using men chiefly for supervisory jobs. Such companies are makers of precision parts. Does this portend even greater employment of female labor to come?

Our second observation is the increase of men hired in industry solely for, or assigned exclusively to post-war planning. Scan the column, "News of Engineers," in this issue, for instance. Some of our editorial brethren are now designated as "post-war editors." Will the idea spread to physicians, plumbers and bell ringers?

German War Equipment

Here is where German war equipment is tops, as gauged by Tunisian observations. German field glasses among tank troops had bigger magnification and field than ours, particularly vital there to identify antitank guns instantly. Their motorcycles are beautiful jobs; their range finders and sights for 88s are superb. In personal kits, such as ground sheets and tents, they have greater lightness yet good quality.

Much inferior Allied equipment was rectified in the midst of the African campaign. Churchill tanks were a big success over Valentines, Crusaders, Grants and Honeys, which had been used earlier. Even at the end, our armored cars were no match for the big German 8-wheelers. The Germans had more quantity and used more skillfully heavy machine guns and heavy mortars. We were deficient, as to numbers, in mobile artillery.

We licked the Germans because of our field artillery and 25-pounder guns, the latter earning the reputation as the world's best all-around gun. Sudden, massed firing of 100 such guns in one spot made Rommel run.

These observations are those of E. A. Montague, Manchester Guardian correspondent, in the Baltimore Sun.

Production for Countries We Occupy

There is no oversupply of munitions, and war procurement will show little, if any, let up for the full 12 months ahead, barring a sudden collapse of Germany. So spoke Leon Henderson and Leo M. Cherne, executive secretary of the Research Institute of America.

The setting was somewhat unusual —the roof garden of the Institute Building, 292 Madison Ave., New York. Some 40 business and technical editors, holding iced drinks in their hands, were seated among the ivy and petunias growing in oblong boxes.

From neighboring buildings opera glasses were focused on Henderson, a big shot and a real character, dressed in chocolate brown, with a cigar stub in his mouth from force of habit. Henderson and Cherne stood side by side, and when one ran down, the other carried on.

A survey by the institute brought out the conclusion that there will be an enormous and continuing demand for production of war materials for the following reasons:

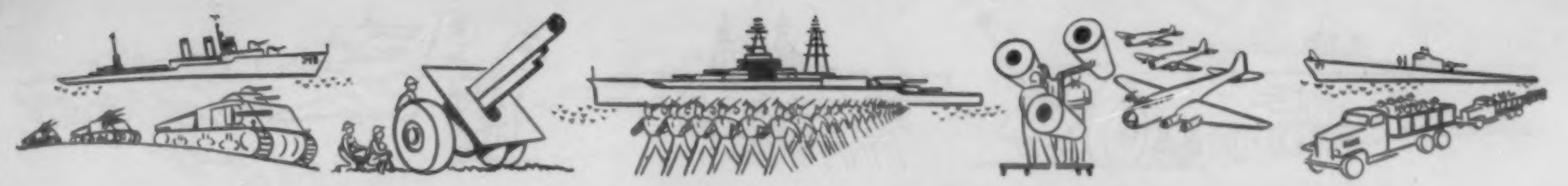
There is no general oversupply, though there have been some limited areas of oversupply which may change with invasion. Most divisions-in-training or awaiting embarkation in the U. S. are not fully equipped. Allied requirements are growing. Aid to China will multiply each month, particularly as more shipping becomes available, which has been apparent recently.

Mexico's request for $400,000,000 worth of used machinery represents a sizeable withdrawal from our community. Russia's demands for aid become more aggressive and will be met more effectively because of improved diplomatic relationships, dissolution of the Third International, and amazing improvement in shipping.

The needs of invasion and reoccupation will call for many essential capital goods, such as public utility machinery, building materials, locomotives, food, clothing and a host of other items necessary for a bare economy.

Metals Critical? They Aren't! They Are!

Metals are plentiful or scarce, depending on who is describing the situation. In production circles there



is the tendency to attest to a great abundance. All along, however, armed forces have been shaking heads and saying: "Critical, critical." It is probable that such criticalness surrounds programs on paper rather than immediate.

Outside the armed forces, and among men who produce metals, we hear such typical statements as: "3,000,000 tons of copper available for 1943 — a lot of metal"; "magnesium is abundant because new plants started earlier and are producing more than expected"; "only steel is honestly critical"; etc.

However, the following is a description of the situation from the mouth of an Army spokesman. The Army should know, but, remember, it tries to plan ahead from now until the crack of doom! Does the Army count, too, on increasingly large salvage returns from the battlefields?

Tin stocks, plus new smelting capacities and ore deposits, plus detinning operations, add up to less than the current rate of consumption. Less critical materials must be used for coating, more tin plate must be electroplated (a saving of about two-thirds), and less tin must be used for solders and bearing materials.

Aluminum is so critical that the balance between the essential demand and supplies may not be achieved this year. Wrought alloys are very scarce. Casting alloys appear to be available for military requirements. Secondary grades (over 1% Fe or Sn) should be used whenever practicable.

Copper, high grades (less than 1% Pb in base alloys), cannot meet the essential demand. Lower grades of brasses and bronzes should be used. Cadmium demand exceeds by far the supply. Zinc has passed through "extremely critical," "less critical," and back to "very critical" during the past three years. The steel cartridge shell program has saved the day for zinc and copper, but other uses have put great pressure on the available supplies.

Bismuth remains critical, but if some unforeseen demand arises, the situation will be desperate. Magnesium is still critical, despite the rapid increase of new facilities. Lead is less critical, and conservation experts recommend the use of lead, alloyed with not more than 2½ per cent of tin for electroplating coatings wherever feasible to save cadmium, tin, nickel, zinc or copper.

Molybdenum is very critical. Essential demand will exceed the 1943 supply. It should not be substituted for nickel unless more than 6 lbs. of nickel can be saved by 1 lb. of molybdenum. Nickel requirements exceed the year's estimated supply, despite huge outlays for additional capacity. Vanadium is critical, and will about hold its own unless too much is used to substitute for the more critical molybdenum and nickel.

Tungsten demand and supply are fairly well balanced. Any increase in demand to conserve more critical materials, or new uses, will upset the situation. Chromium availability is fair. Low carbon ferro-chromium is very critical, due to insufficient furnace capacity. About 95 per cent of the latter material is used for steel making. In manganese there is good availability.

Alloy steel of electric furnace grades is very critical because of limited furnace capacity. Open hearth capacity is more available, and open hearth should be used wherever possible. Carbon steel is fairly available, particularly in smaller bar sizes of Bessemer types. Malleable iron, with the present excess of production capacity, is generally available. Gray cast iron is readily convenient, largely because of the large, unused automobile engine capacity.

Bars over 2 in. are very critical; plates, wire rope, wire products and castings are less critical; structural steel, piping, sheet and strip, and rail steel bar products are generally handy; low-alloy, high-tensile plates are fairly available, due to action of the Army Service Forces and WPB limiting the use of molybdenum and nickel in these plates.

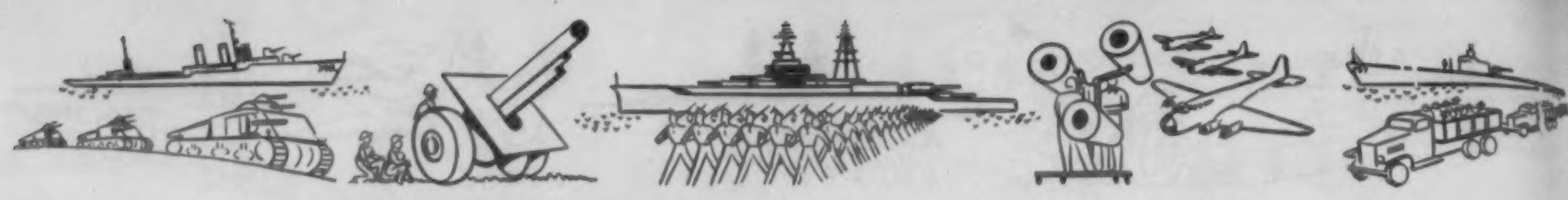
"Sweet Alice" Today

by V. M. McConnell

"She wept with delight
When you gave her a smile,
And trembled with fear
At your frown."
Ah, that was the way
With Sweet Alice Ben Bolt
Till the jolly old war
Hit the town.
My word, what a change
Has come over the gal.
Now she punches a clock
In a shop
Where she labors each day
At a highly skilled trade
For a pay check
Approaching the top.
Let us rise up and honor
Sweet Alice Ben Bolt
And the way she is
Doing her part,
While we hope against hope
What with all of her skill
That she's not a mechanic
At heart.

"Stitching"—What, Not Leak?

There often is confusion in terminology and nomenclature in a new industry or new process of an old industry. Take "stitching." We believed it meant tack welding, or fastening two pieces of metal together at spots at intervals with leak potential spaces between. But along comes General Electric to announce "droppable airplane gasoline tanks stitched electronically."



"Yes, but merely stitched tanks would leak," we remarked. R. T. Gillette, G. E. expert on resistance welding, however, sees no objection to the word "stitching" in this application. "You can make waterproof cloth leak-proof if you make your stitches close enough together. Though stitching is not an A.W.S. accepted word, it is a good one to use as a change of pace. Actually, the seam welder here operates on the same lines as a sewing machine, but its stitch is a continuous one," states Mr. Gillette.

"Sunday School Collection"

The total gross debt of the United States is only 1.17 per cent of the inventory value of the wealth of the United States. So writes the irrepressible Harold L. Ickes in the *American Magazine* for August. Our physical assets are worth 12 trillion, 23 billion dollars, or $89,000 for every man, woman and child. This does not include credit for our vast gold supply buried in Kentucky, because it has "little industrial value."

Our total gross debt on June 5 stood at $140,304,018,663.51, which Mr. Ickes describes as a mere "Sunday School collection." The author pooh-poohs fears of exhaustion of our oil reserves. He reports: "One of the country's oil-cushioned engineers says that we haven't really started to use the petroleum that is in the ground."

He values our now workable coal the highest at over 8 trillions, followed by iron ore, then more coal at deeper depths, public and private buildings, petroleum, oil shale, gas, forests, farms, fisheries, utilities, manufacturing industry and water power.

And how the professors of economics will toy with that idea in front of their freshman classes! One smart freshman will point out as follows: "Yes, I own $89,000 worth of assets, but I've got to share that with many of my offspring — perhaps thousands of generations to come. Perhaps my real current share is only 30 cents."

Then the professor will reply: "Yes, but with wealth one begets wealth. John D. Rockefeller started with $53 and look what he created. Or, perhaps, you say Rockefeller did not create — he simply amassed wealth. All right, then, let's create. With our present resources we'll devise machinery and instruments whereby we smash atoms and harness the resulting power — or we'll adapt and convert the power from the sun. With your $89,000, my boy, you'll create — not merely amass — a real wealth of $89,000,000, say. Not bad going, eh what?"

How Would You Answer the Banker?

"We believe that consumers' goods, such as automobiles, radios, refrigerators, etc., will be rather stiffly priced as civilian goods are again produced after the war. What do you think?"

It was the banker speaking. We were enroute to our suburban town on a hot, humid day and we weren't in the mood to talk. Besides, we wanted to read more details in *The Sun* of the Allies' progress in Sicily. And, knowing that he was smarter than us, we agreed with a grunt.

"Will there be prosperity or depression when peace comes?" he ventured next, continuing: "We at the bank believe that because of careful post-war planning, skill acquired in converting rapidly, and stupendous needs for the essentials of life, there'll be a boom." Again we grunted agreement.

"You're with *Metals and Allied Products magazine?*" "METALS AND ALLOYS," we corrected. "When peace comes," our irrepressible harasser went on, "the housewife will still save tin cans, won't she?"

At last we began to feel on the banker's level — perhaps a shade above. We folded up our paper and launched forth: "No, when we lick Japan we'll again have enough tin. Again, it is an expensive process to separate tin from the steel. Also, only a half of one per cent of the weight of the can is now tin, as against $1\frac{1}{2}$ per cent a few years ago."

"Yes, but won't the steel be valuable?" "Not valuable enough, especially being such a light steel," we replied. "Besides, the housewife will not bother with can salvage when the emergency is over."

"Of course, the industrialist will no longer do all this sorting of scrap after the war," he ventured. "Yes he will," we answered vigorously, as we continued: "Steel and non-ferrous metals are ever more and more tailor-made, and the steel maker or copper refiner must be more and more careful to get the specified analyses into his finished product. A nail must have much different qualities than a screw, and the correct scrap must be used for each."

"Yes, but can't the bulk of scrap from the miscellaneous scrap pile go to the steel mill and be used in, say, 75 per cent of the finished products, just as it is, without sorting?" he asked. To which we replied: "The only product that could be made from that mess would be sash weights."

But the train was approaching our station. Reader, did we inform the banker correctly? Your thoughts, in writing, will be passed along to him. He is the economist with a leading New York bank.

Synthetic Rubber

"Don't have too high hopes over synthetic rubber," recently cautioned a consulting engineer, who has called his shots correctly in the past. "A synthetic tire may last as long as a natural if you don't drive over 35 miles an hour and if you keep it properly inflated. But what average motorist will do that? Synthetic rubber just doesn't have the inborn elasticity!"

That Old Alibi—the Printer

In our June issue we stated — rather our printers stated — that aircraft embraced 83 per cent of all munitions produced in April. The correct figure is 33 per cent. In making a last minute alteration to our type, the error crept in.

Old Materials Get a New Chance

Perhaps too often an old design material is abandoned when a new flashy material comes along. There is an inclination for manufacturers to get on the band wagon, whether it be plastics, magnesium, or some other new product that has struck the popular fancy. Too often the proponents of the older material make no fight to retain the public's favor and, in a spirit of defeatism, allow the new to reign supreme.

Fortunately, the war has given a new chance to many of these older materials. With modern science and techniques applied, the old materials have had their faces lifted and are able to hold their own — at least for the time being. Thus plywood is a striking example. The "mosquito" bombers of the R.A.F., light and speedy, have done spectacular work against the Axis.

Again, wooden springs are as old as antiquity. The old archer's bow was perhaps the first example of the springiness of wood. Kings and their ladies rode in turnouts, made easy-going by wooden springs. New techniques are bringing them up to date. Stoneware and ceramics stem from the cave man, but had been given a back seat by moderns like stainless steel.

Recently we have heard architects wax eloquent over mud or adobe houses. Mixed with stone and other materials they can be made cheaply and with reasonable attractiveness.

These older materials have been given a new deal and allowed again the chance to compete with the more moderns. Just now copper producers have furrowed brows as they wonder whether copper will become a back number. But perhaps its salvation lies in new methods and treatments for extracting lean ores cheaply and for making the ingot metal more serviceable.

Entire industries have had to be rejuvenated to survive. Railroads have come far from the "public-be-damned" days in their competition with trucks and passenger automobiles.

Even if the rejuvenated oldsters in materials have only come forward because of the war emergency and again slip back into forgotten niches, we will have gained experience and made worthy experiments. We will at least have left no stone unturned in searching for the usefulness of everything in the light of modern know-how.

There is more satisfaction in the final choice when all possibilities have been explored.—H. A. K.

The A.I.M.E. and the A.S.M.

Some Comments on our May Editorial

We are glad to publish at this time letters received from readers of the editorial "Our Two Great Metal Societies," published in Metals and Alloys for May, page 957. The editorial discussed the announced intention of one society to consider means of meeting the competition from the other, and sug-

High strength and workability of Inland Hi-Steel are of great advantage in building heavy field gun and howitzer carriages.

Built Light and Tough with Inland Hi-Steel

Carriages for America's large field guns must be built to withstand terrific impact and torsion stresses—be as light as possible—and, because of the urgency for equipment of this kind, must be made of steel that is easily fabricated and retains its strength under relentless pounding. Inland Hi-Steel—the low-alloy, high-strength, corrosion-resistant, structural steel—meets these requirements.

Inland Hi-Steel is ductile, and can be readily cut and formed cold. Its endurance limit is 50% above ordinary steel, and its impact strength at −25° F. is four and a half times higher. Under proper annealing its yield strength is increased by approximately 40%.

It is easily welded by arc, spot, resistance or flash methods, or by gas.

Long tested and approved by builders of road machinery and other heavy equipment, Inland Hi-Steel is now available only on special order for wartime use. When Victory is ours, this modern steel will again be available for peacetime products.

SHEETS • STRIP • TIN PLATE • BARS • PLATES • FLOOR PLATE • STRUCTURALS
PILING • RAILS • TRACK ACCESSORIES • REINFORCING BARS

ARMY E NAVY

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gested that instead of fighting each other the two societies agree that the A.I.M.E. shall be the technical society of *metal-production* and the A.S.M. the metallurgical society of *metal-working and treating.* Many comments were received other than those published below, but their authors have asked that they not be printed.

Among the latter was one strong objection to the editorial, made on the basis that no dual competitive situation exists between the two societies and that we are therefore placed in the position of trying to start a fight. Our answer to this is simply that the president of one society in February publicly asked for suggestions to meet the competition from the other, thus definitely establishing the existence of the competitive situation before we stuck our necks into it in a sincere attempt to *prevent* its degenerating into a fight.

The letters follow:

From A.I.M.E.'s President

To the Editor: Regarding the problems of welfare and growth of the Metals Divisions of the A.I.M.E., in the presence of and, as may be said, in competition with A.S.M., the editorial suggestion in the May issue that A.I.M.E. leave physical metallurgy to A.S.M. and concern itself exclusively with the production of metals, will be read with a puzzled sense of incredulity by many members of the Institute of Metals Division of A.I.M.E., whose predominant interest, like my own, has always been physical metallurgy and who contemplate with pride and satisfaction the substantial contribution made by our Institute to the organization and development of that subject.

About 60 per cent of the titles, in the first Institute of Metals volume (then called *Proceedings*) of the present series, constituting Divisional publications of A.I.M.E., represent scientific studies of metals and alloys, formerly classed as metallography and now rather generally called physical metallurgy. More than 90 per cent of the titles in the last volume of *Transactions* are of this character.

In common with the writer of this editorial I belong to both societies and have no desire to foster a competition that will jeopardize the welfare and healthy growth of either organization. At the I.M.D. dinner last February I stated my impression that A.S.M., formerly the American Society for Steel Treating, cultivated primarily the *Art* and secondarily the *Science* in our common sphere of interest and that our Institute cultivated rather more the *Science* and somewhat less the *Art.* Further, that many of us belong to both organizations and hope there may be room for the cultivation of separate virtues in each environment.

Certainly, it will not please the great body of I.M.D. members who have found their most valued scientific associations and community of interest in the Institute of Metals Division of A.I.M.E. to leave the scientific study of metals and alloys to the society which primarily brings together men who are first of all interested in practical every-day matters of detail affecting the heat treating and fabricating of metal products. As far as I can learn, our I.M.D. members believe that our greatest strength lies in the fact that we are a professional group and maintain high standards of qualification for membership and high publication standards. As previously noted our publications have centered in physical metallurgy and it is clearly our *first* obligation to maintain leadership in sponsoring *scientific* progress in the field of metal technology.

The history of the Iron and Steel Division of A.I.M.E. is rather different and reveals a closer adherence to the interests of production, as contrasted with fabrication, but iron and steel and the other metals are so inextricably interwoven in their scientific aspects that parallel interests must inevitably arise and grow with increasing fundamental knowledge.

Thus, A.S.M. cannot serve its practical interest without some excursion into the world of imagination, speculation, and theory and those who view Physical Metallurgy as their field cannot disregard the practical benefits growing out of their collective research.

I cannot believe that A.S.M., with its immense reservoir of men actively working in the various fields of processing and marketing metals and alloys, will look adversely upon an effort by the Metals Divisions of A.I.M.E. to balance their theoretical program by encouraging forward-looking so-called "practical" metallurgists, who may ultimately be able to qualify as full professional members, to join the Institute as Associate Members and participate in various activities combining theory with practice, or developing certain group interests.

Time and its display of changing opportunity will determine the details of any such program. I believe there need be nothing destructive in this friendly competition between these established metallurgical organizations. To paraphrase an oft-repeated phrase, "In union there is strength," — in united and sympathetic resolution to support one another through the complexity of our related interests there will be strength to make our nation supreme in its metal science and technology.

C. H. MATHEWSON

May 28, 1943

From Dr. Gillett

To the Editor: In the first place the phrase "supremacy spheres" or "supremacy areas" which you ascribe to me on page 959 of your May issue was not mine, but Van Deventer's of *The Iron Age,* and credit was given to him when I quoted it several years ago. [Our apologies herewith to both Dr. Gillett and Mr. Van Deventer.—F.P.P.]

Concerning the editorial on the two metal societies, I don't agree with your conclusion that all overlap between A.I.M.E. and A.S.M. should be eliminated. Any papers committee is human and may reject a useful paper because it doesn't jibe with the ideas of some vociferous member of the committee.

To have only one technical society permitted to publish papers on physical metallurgy would not be healthy. The A.I.M.E. has published many highbrow papers in that field, some of which were masterpieces, some quite unintelligible to me but presumably valuable to someone. I doubt if all of these would have been published by A.S.M. While I personally doubt whether some of these (as well as some of the A.S.M. papers) are worth the paper and ink, I prefer some useless publication to the chance of censoring out some that should be published.

The A.I.M.E. is a purely professional organization, unhampered by too many salesmen. A lot of the talks at local A.S.M. chapter meetings have been blatant sales propaganda for the reason that the chapters have a monthly meeting in spite of hell and high water, and often the only available speaker is one who is purely a salesman. While the commercial angle has been pretty effectively kept out of the A.S.M. *Transactions,* it has not been kept out of chapter talks. The A.I.M.E., especially in the Iron and Steel and Institute of Metals Divisions, has been so run that one has scarcely even a subconscious fear that a paper accepted there is motivated by any other than a

(Editorials continued on page 308)

Operating a Modern Salvage Department

Recurring shortages in different war materials (steel is now the outstanding problem) underline the need for ceaseless attention to industrial salvage operations, which must henceforth provide the bulk of the scrap for our mills and foundries. The case history presented herewith demonstrates the importance of a centralized plant system and of the engineering factors in an efficient scrap-handling program. —*The Editors*

by KYLE A. FOWLER

Salvage Supervisor,
Westinghouse Elec. & Mfg. Co., East Springfield, Mass.

Aluminum scrap being transferred from a small pan to a large lock-protected container.

TO MANY PEOPLE the word "salvage" means hunting out dormant scrap and placing it in the hands of a scrap broker. However, in its broadest meaning, it should embrace proper segregation, classification, and preparation of waste materials; it should also include methods for re-operating scrap in order that it once again may become usable material.

Preliminary to organizing a salvage department, a thorough study should be made of all types of scrap available in your plant. This survey should include everything—metals, oil, solvent, wood, and even paper. It should then be determined, tentatively, what can be re-operated. The word "tentatively" is used because continual effort should be expended in order to increase the quantity and variety of re-operated material. Where it is found that a large amount of work must be done by a salvage department, it is usually best to have two separate groups of workers handling the operations—one engaged in re-operating processes and the other in segregating and handling the scrap material.

Scrap Segregation

Material segregation starts at the source. To set up this program properly will require much equipment, a man to constantly follow the procedure, and an educational program for the men on the machines. The latter will be the hardest since machine operators are interested chiefly in production. They will empty two or three partially-filled pans of scrap together in order to obtain an empty pan for their parts, regardless of the material in those pans. Only by carefully explaining the loss which the company must take for mixed scrap and by appealing to patriotism, pointing out the metal scarcity and its effect on the war effort, will their cooperation be obtained; once convinced, however, they do their utmost to make the salvage program a success.

Not only must different types of metals be kept separate, but also different alloys of the same metal; color coding is an effective means for carrying out this program. A color is assigned to each individual item which must be segregated; this color identifies the item through the entire scrap handling process, from the time it leaves the machine until it leaves the salvage department. Containers of a specified color are placed at the machines and in most cases are small due to space limitations.

These small containers are emptied periodically into a larger one of the same color for transportation to the salvage department. The large container may be anything suitable for transporting the material from one point to another. One very effective means is a drum skid; this can be built by the maintenance department by widening an ordinary skid so that it will hold four drums—a rack with a chain attached is added to prevent the drums from falling off. This skid may be moved readily by means of an electric truck or hand truck; gondola-type trailers are excellent for handling chips and turnings.

Many plants prefer to have their large containers covered and locked; usually one person is responsible for placing material in them. When scrap is brought

Scrap being dumped from a small pan into a drum that is periodically delivered to the salvage department. The pans are located near each machine for the convenience of the operator.

to the salvage department, only men properly trained in its segregation should be allowed to handle it; this group is also responsible for storage according to proper classification. All sorting operations which cannot be performed at the source, such as assemblies composed of more than one material, are handled by these men.

All scrap preparations, such as cutting large pieces into smaller ones with an alligator shear or removing insulation from wire, is done by this group. The alligator shear is an important part of every salvage department since it cuts bulky material into smaller pieces for easier handling and more economical storage. Large pieces of steel can be cut to make heavy melting scrap which is worth \$2 to \$4 more a ton than it would be worth in its unprepared state. One man should be responsible for checking company scrap-sheets or tags; these are shipped with salvage material as a part of the cost-control set-up.

A Salvage Inspector

A salvage inspector should travel from one department to another making certain that proper containers are being used for the proper material. This man should work in conjunction with the foremen of the various departments and should report any violations as soon as they occur. By doing so any error involving material placed in an improper container can be straightened out before considerable contamination has taken place, thus preventing loss. Should a small container become contaminated, or escape the eyes of the salvage inspector and be

Alligator shear in operation; the larger pieces of scrap are cut down in size here.

dumped into the large container, the entire lot will be lost. It is obvious, therefore, that good inspectors are a necessity to a successful salvage set-up.

Inspectors should also be responsible for placing liquid materials in the proper drums; a good way of doing this is to number the drums. When a department requests a drum for a certain grade of scrap oil, the salvage inspector assigns a drum to a responsible person in that department, keeping a record of the number. When the drum arrives in the salvage department, the inspector checks it to make sure it contains the material for which it was assigned.

If, through error, some other material has been placed in the drum, the inspector should call this to the attention of the person responsible for the drum. It is quite likely that errors will occur when the set-up is first installed; however, a few such incidents brought to the attention of the proper people will soon straighten out the difficulty to the satisfaction of all concerned.

Bulky skeleton-scrap should be baled to secure maximum market price; baling also reduces handling and conserves shipping space. Some skeleton waste may have usable metal for small parts and this possibility should be thoroughly investigated. At the East Springfield Westinghouse plant, stator laminations for a small motor are punched from the center of large motor laminations.

Briquetting

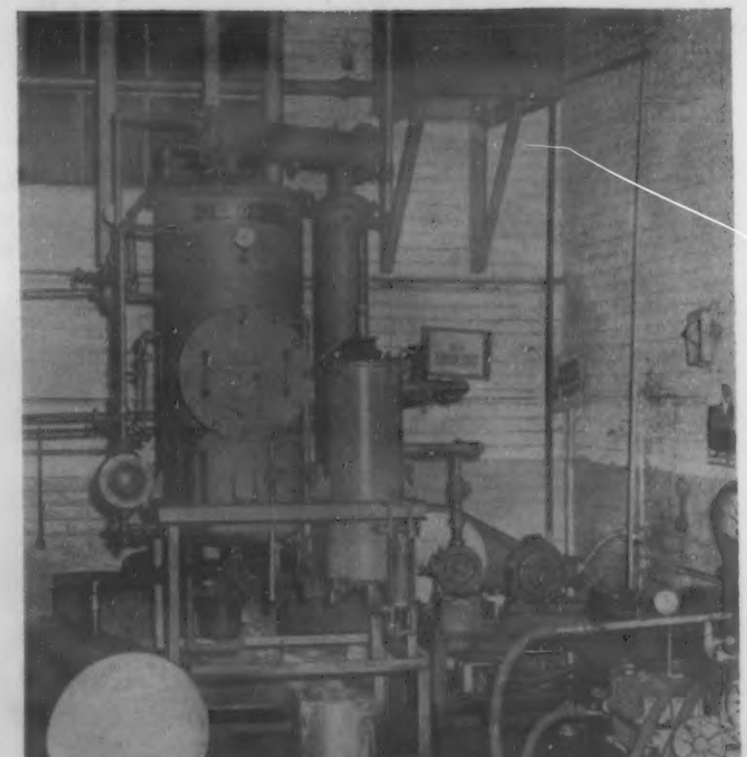
Some plants can use a briquetting installation for disposing of cast iron borings and steel turnings; this equipment consists of a crusher, a hopper, a pneumatic system for conveying the crushed chips to the hopper, and a briquetter. The cast iron borings are allowed to by-pass the crusher because they are suitable for briquetting as they come from the machine. The steel turnings are fed through the crusher to produce chips small enough for the operation. A high speed blower forces the chips into the hopper which is directly over the box of the briquetter.

Passing into the box through a vibrating screen, the chips are compressed in a die at a pressure of

Part of the machine for briquetting cast iron borings and steel turnings. The briquettes are 2¾ in. in dia. and vary in thickness from 1 to 3 in., depending on the material. The machine, combined with a strict system of separating scrap metals, enables Westinghouse to maintain more rigid control over the composition of castings.

2300 lb. per sq. in.; a briquette 2¼ in. in diameter and varying from 1 to 3½ in. in length is produced, depending on the type of chip. Briquettes can be used in the foundry as a substitute for steel rails; this relieves the shortage of critical material and saves transportation both to and from the plant. Naturally, the work of the briquetter is assigned to the group engaged in re-operating processes.

The re-operating group may perform many other tasks which will depend a great deal on the work done in a particular plant. However, there are some items common to many plants. Nearly everyone uses solvents for cleaning—varsol, trichlorethylene and others common to industry. There are many companies engaged in the manufacture of distilling equipment and it will pay dividends to investigate the possibilities of reclaiming these products. Likewise, lubricating, hydraulic and cutting oils may be classified for re-operation, reclamation equipment may be purchased from manufacturers of oil purifiers, or in many cases can be constructed right in the



Varsol reclamation still where cleaning solvents are made good as new.

plant. Many plants realize a definite saving through laundering their own wipers. Last year the Westinghouse East Springfield laundry washed over 125,000 lbs. of these rags.

Many operations set up now to guard against shortages will be continued for economical reasons long after the shortages have disappeared. Westinghouse has a typical case of this kind which concerns the making of scratch pads from obsolete reports. Standard 8½ x 11-in. sheets are packed in a frame with chip board at measured intervals; these are compressed by means of a screw similar to a letter press. One side is then coated with a special padding compound and when this material is dry the pads are removed from the press and are trimmed to proper sizes. This project was set up during the paper scare of a year ago. However, today, the plant is using four sizes of scratch pads made in the salvage department that cost from ½ to 1½ cents each. These are comparable with purchased pads which normally cost 6 to 11 cents each.

Used corrugated boxes may be cut into standard-size sheets to be used for packing equipment, photographs, and the like. Westinghouse has successfully substituted corrugated-board tote boxes for metal ones for many applications. These paper containers are used on the floor for handling light parts and on storeroom racks for heavy parts, and are so strong that an ordinary man cannot pull them apart.

Tool Conservation

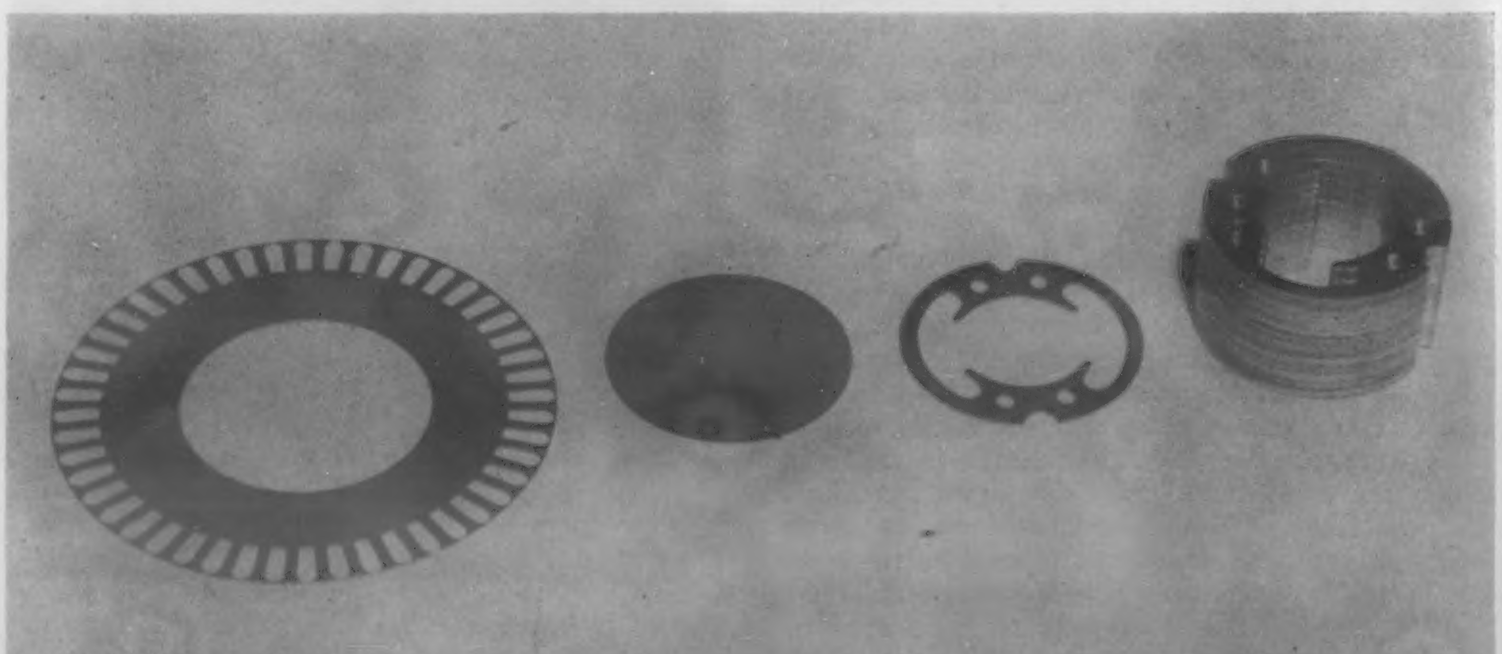
The material conservation committee has the job of prolonging the life of tools, cutting down the use of scarce materials and general conservation about the plant. Much has been accomplished by hard chromium-plating new tools; this prolongs life as much as 10 times. Old worn tools can be re-built to normal size by this method thus placing them back on the production front. Small pieces of critical material can be stored in racks for small-parts use; such pieces, in ordinary times, are scrapped. Rubber and metal tubes have been replaced by less critical plastic substitutes.

The hard chromium plating of a tool used for making a valve for a war product is an interesting example of tool conservation technique. It was necessary to grind this tool once or twice each shift, the average being 4 to 5 grinds per day. Such grinding wore away much valuable steel, due to the formation of deep scores in the groove. By chromium plating this tool, it has performed perfectly for seven full 3-shift days after which it was removed, ground and re-plated. The first performance of the tool was equalled or bettered in several instances. It is estimated that this chromium plating process will save approximately 450 lbs. of steel a year in this one application.

Once a salvage department is started in a particular plant individual problems will arise; with a certain amount of study such problems can be satisfactorily met. Many plants are starting salvage departments as a patriotic measure; at the same time, the program will get rid of the unsightly and uneconomic scrap pile. It takes a war to remind the American people and industry of their extreme waste of natural resources. Salvage departments should be continued after the war in order to conserve this precious heritage. A properly organized salvage department will do this and in addition will repay its operators many times over in actual cash savings.

By doing our utmost to utilize waste material in our own plants and by returning unused scrap material in its proper classification to its original source, factories will be kept running at maximum output and a speedy victory will be assured.

A good example of making parts from material that otherwise would be scrapped is here illustrated. Here the disk punched out from one motor stator lamination has been taken and punched out again into a lamination for use in a smaller motor stator.



Cast Dies for Forging Shells

By P. ATTENBOROUGH *The International Meehanite Metal Co., Ltd., England*

Cast-to-shape shell-forging dies have been the answer to the pressure on steel die-forging and machining facilities in many British plants. This article is a report of successful English experience with Meehanite iron piercing and nosing dies, and outlines service factors, production-life comparisons and limitations of such dies. A feature of the article is a chart of shell-forging processes, showing the possible die application for high-strength castings.

—The Editors

THE OLD IDEA that all "cast iron" is a weak and brittle material has been dispelled by the considerable application found for specially-processed, high-duty irons for jobs where substantial resistance to impact and other stresses is required. Notable among these are several shell and bomb forging installations, especially in Great Britain, where Meehanite or other "heavy-duty" irons are not only giving adequate service, but are actually out-performing some of the conventional die materials.

Shell Dimensions and Output

Under present conditions the size of shell forgings range from 1½ in. dia., weighing 2½ lbs., to those of 16 in. dia., weighing over 2,000 lbs. Output quantities are considerable, an indication of which, for example, is a report that 600,000 anti-aircraft shells were fired by one of the Great Powers, during an airplane attack, in one day.

New methods of warfare have increased tremendously the demand for smaller caliber, of 5 in. dia. and under, for use by mobile armored divisions, anti-aircraft guns and small guns mounted on long range bombing planes. For these sizes considerable success has been enjoyed in Great Britain with the use of cast dies (Meehanite iron) for forging the projectiles.

One of the most interesting applications of Meehanite dies is in the severe operation of horizontal nose forging. This development is recent and still somewhat experimental although very promising. Fig. 1 shows the upper and lower dies, which form between them the bodies of two shells from one billet. These shells are 3 in. armor piercing solid nose. This die assembly also forms the nose contour.

The Meehanite used was process "GA" (unalloyed). Forging temperature is 2100 deg. F. and life so far given is 6,000 forgings. Steel was previously used, but no information is available as to either its composition or service life.

Heating and Descaling of Billets

Prior to forging operations, billets are heated to the required forging temperature, which may vary from 2150 to 2300 deg. F. Furnaces used may be:

(1) Batch or box type; gas or oil fired.
(2) Port hole furnace; gas or oil fired.
(3) Continuous furnace:
  (a) straight line type with pusher usually designed for square billets, gas or oil fired.
  (b) circular rotary hearth for square or round billets — gas or oil fired.
(4) Electric furnace:
  (a) high frequency induction furnace
  (b) electrically heated salt bath.

Fig. 1. The upper and lower dies that form between them the bodies of two 3-in. shells from one billet.

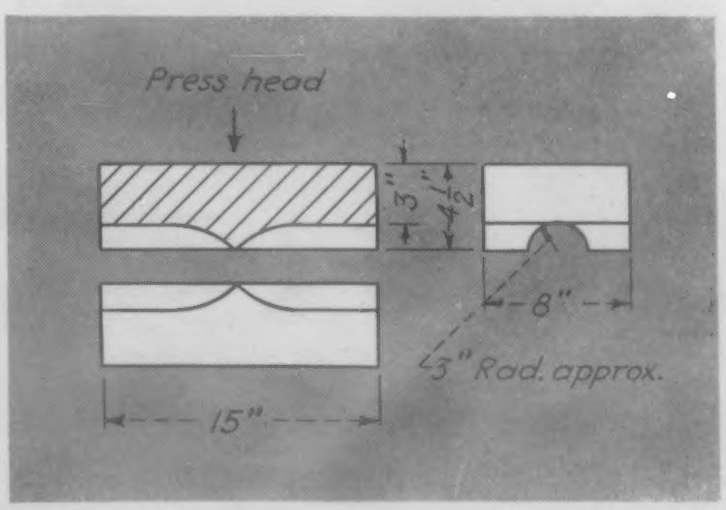


Table I—Performances of Meehanite piercing dies and of alloy steel dies compared.

Meehanite			Ni-Cr-Mo Air-Hardening Steel		
Installation	Life	No. of times machined	Installation	Life	No. of times machined
1	14,095	4	1	8,715	7
2	19,017	6	2	14,502	6
3	35,207	20	3	23,566	—
4	22,650	4	4	4,100	3
5	3,696*	4	5	8,571	4
6	19,172	5	6	13,682	—
7	14,635	4	7	8,801	—
8	24,621	6	8	9,985	—
9	17,047	3	9	13,336	—
10	16,129	5	10	12,780	—
11	18,436	—	11	11,513	—
12	21,284	—	12	6,932	—
13	26,698	—	—	—	—
Average (approx.)	18,000	—		11,000	—

*Faulty Casting

The pre-heating operation is most important in its effect on die life and a study of individual installations explains many anomalies in service obtained. For example:

Improper heating (too low a temperature) means a greater load on the die and reduces its service life.

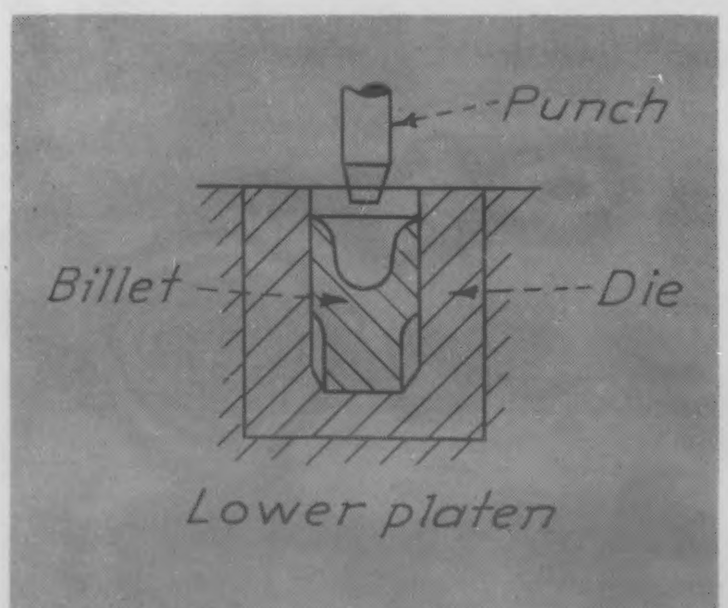
Excessive production of scale—due to oxidizing furnace atmosphere—is detrimental to dies and tools.

Uneven heating tends to force the piercing punch towards one side of the shell throwing the shell forging out of concentricity and gives more intense wear locally on one side of the die.

Abnormal loss of heat in transfer of billet from furnace to die also favors excessive die wear.

Descaling of billets follows pre-heating, and is effected either mechanically by rollers or cogs; or hydraulically by directing several streams of high pressure water on to the surface of the billet. The efficiency of this operation has a great influence on die life.

Fig. 2. The piercing punch that pierces and displaces the metal of the billet in forming the shell.



Forging Operations

The subject of forging is too extensive to discuss in more than its broader issues, giving only detailed information where iron dies are or can be employed. Three basic methods are employed:

1. Piercing and drawing.
2. Upsetting.
3. Piercing and rolling. (Witter method)

Many modifications exist in all these processes. [For details of these shell forging methods, the reader is referred to the article by Schranz in METALS AND ALLOYS for September, 1941.]

The older conventional methods in use during the last war, since improved and speeded up, are widely used today. Newer methods are also used, especially for shells over 6 in. in dia.

The first operation makes use of a vertical piercing press where the heated (usually square) billets are placed in a die in the lower and stationary platen, the piercing punch being fixed to the upper and moving platen. The piercing punch moves downward to pierce and displace the metal from the center of the billet to the sides of the die or piercing pot. (Fig. 2).

Cast dies have been used in quantities for some time for this operation. Comments received from Ealing Park Foundry Ltd. on this type of die for piercing, with additional reference to bomb dies, were as follows:

We have made these castings since 1938 and our original experiments on piercing dies were recorded in a service report in 1939. The original series of castings gave the following results:

Table II—Weights and Dimensions of Shell Billets and Forgings

Shell size	Billet dimensions (if square) Billet weight lbs.	Across flats, in.	Across round corners, in.	Length, in.	Pierced Forged Outside dia. in.	Length in.	Finished Drawn Forging Outside dia. in.	Length in.	Largest Inside dia., in.
U. S. 75 mm.	20.2	3-1/32	3-3/4	8-5/8	3-3/4	9-5/16	3.26	13.86	2.13
Brit. 18 lb.	24.1	3-1/2	4-1/4	7-3/8	4-1/4	7-3/8	3.29	10	1.89
U. S. 90 mm.	36.6	3-1/2	4-3/4	11	4-1/4	12	3.92	14-1/2	2.55
Brit. 25 lb.	37.0	3-1/2	4-1/4	11	4-1/4	12	3.7	15-3/4	2.17
Brit. 3.7 in.	39.0	3-1/2	4-1/2	10	4-1/2	12	4	15-1/4	2.43
Brit. 4.5 in.	47.0	4-1/2	5.56	8-3/4	5.56	10-3/4	4.875	15-3/4	3.45
U. S. 104 mm.	49.0	4-1/2	5-1/2	9	5	10-1/4	4.55	17-7/8	3.3
Brit. 60 lb.	99.5	5-1/2	6-1/2	12-1/4	6-1/2	12-1/4	5.50	18-5/16	3.04
6 in.	160	6-1/4	7-3/4	14-3/4	7-3/4	16	6-1/4	26-5/16	4.17
155 mm.	142	6-1/2	8	12-3/4	8	14 3/8	6-3/8	26-3/4	4.95
7.2 in.	230	7-1/4	9-1/2	18	9-1/2	22	8	32	6.00
8.0 in.	310	7-1/2	10-1/4	22	10-1/4	25	8.6	37	6.47
9.2 in.	366	8-1/4	10-1/2	19-7/16	10-11/16	23-3/8	9-11/16	35-1/3	7-5/16
12 in.	987	11	13-7/8	29-11/16	15-1/2	25-3/8	12-11/16	42	8-1/16

(1) Type GA Meehanite (unalloyed) — 800 shells
(2) Type GM Meehanite (alloyed with nickel, chromium and molybdenum) — 6000 shells

We have continued to supply large numbers of castings for piercing dies, both for bombs and shells and have standardized on Type GM.

It is very difficult to give definite figures for the life obtained. There is such variation in the treatment during operation that differences in material are frequently overshadowed, and identical dies, either castings or forgings, may have widely different service life. Many dies fail due to cracks. If a die is not accurately fitted to the bolster, the life may be less than 100 forgings.

The most recent figures for the production of 3.45-in. shell in Meehanite dies show variations from 1,000 to 35,000. The average life is 20,000 with four withdrawals for re-machining.

Nickel-chromium-molybdenum air-hardening steel gives the same variation and an average of 12,000 shells.

More precise information is given by actual service records (see Table I) of piercing die performance, making a direct comparison between Meehanite and the air-hardening nickel-chromium-molybdenum steel. The Meehanite used was Type GM. The die was used for a piercing operation for 25-pounder smoke or high-explosive shell (3.5 in. dia.)

As far as bomb production is concerned, a report shows that Type GM dies used for forging aero bombs, 40 lbs. weight, gave 3500 forgings, as against 2500 forgings obtained with a nickel-molybdenum steel.

The properties required by piercing dies are strength at elevated temperatures and resistance to thermal gradient stresses. A degree of surface crazing produced on the die in use is reported to be indicative of satisfactory performance.

Additional thermal stresses are imposed by cooling methods adopted to increase the life of the punches or piercing tools used. These usually are in adaptation of a water spray, in the form of a ring jet, which is directed at the top of the punch after withdrawal. The water cools the punch and at the same time washes scale and debris into the die.

Shell Nosing

The most widely used type of die made in Meehanite is that used for shell nosing. When the cleaned shell forging is received by the machine shop, it is machined and the final nose shape given by a forging operation. The procedure is shown clearly in Fig 3, which is standard practice for 4.5 in. diameter shells.

A summary of factors affecting die life for both piercing and nose forming are:

(1) *Grade of material*—Type GM (the alloyed Meehanite) proved most successful. Heat treatment can give some improvement in results either by quenching or tempering, or by a stress relief anneal, although the benefits of heat treatment are not always positive ones.

(2) *Correct foundry practice* in the placement of gates and runners to give absolute solidity in the comparatively heavy sections obtained, with the type of Meehanite used, is essential.

(3) *Premature die failure* can arise from improper fitting of the die to the bolster. It is important to fit the die squarely and tightly enough so that the load is taken by the bolster, otherwise dies may fail by bursting (Fig. 1). The die should also be concentric with the plunger or shell forming tool if employed.

(4) *Size of bomb or shell*—as the shell size increases the residual heat in the die increases, and hence the service conditions become more arduous. Information received shows that, with existing shell forging equipment, no piercing dies for shells have been made for calibers larger than 4.5 in., similarly nosing dies have been usually limited for shells 3.45 to 4.5 in. in dia. Bomb dies so far made in Mee-

hanite may be slightly larger but no confirmatory data have been forthcoming to date. As a general guide of the weights and dimensions of shell billets and forging sizes, Table II gives information on shells from 75 mm. to 12 in. dia.

(5) *Degree of deformation:* The greater the degree of deformation in piercing ((everything else being equal), die life will be decreased in proportion. For example, the life of a bomb die is much shorter than that of a shell die as the sharper taper at the base causes more severe wear and greater stresses, and failure is generally due to cracks.

(6) *Pre-heating of shell:* The control of the preheating treatment of billets before piercing, or preheating shells being forged is important as is also the speed of handling after heating.

(7) *Treatment of die in use:*

(a) Cooling by water spray: This applies only to piercing dies used in the conventional vertical press. An outline of the method of prolonging punch life by means of a water spray has been given already. One effect of the cooling water falling directly into the die will set up additional thermal stresses, and presumably reduce its effective life.

(b) Dressing material: Frequent dressing of the die promotes easier flow of the shell form and assists easier withdrawal of the forging and hence increases die life.

(c) Frequency of operation: An example is cited where two identical plants, operating on similar piercing operations, gave 50 to 100 per cent increase in die life where the output per hour was decreased 50 per cent.

(d) Water cooling of die: Certain piercing and nosing forming installations obtain greater die

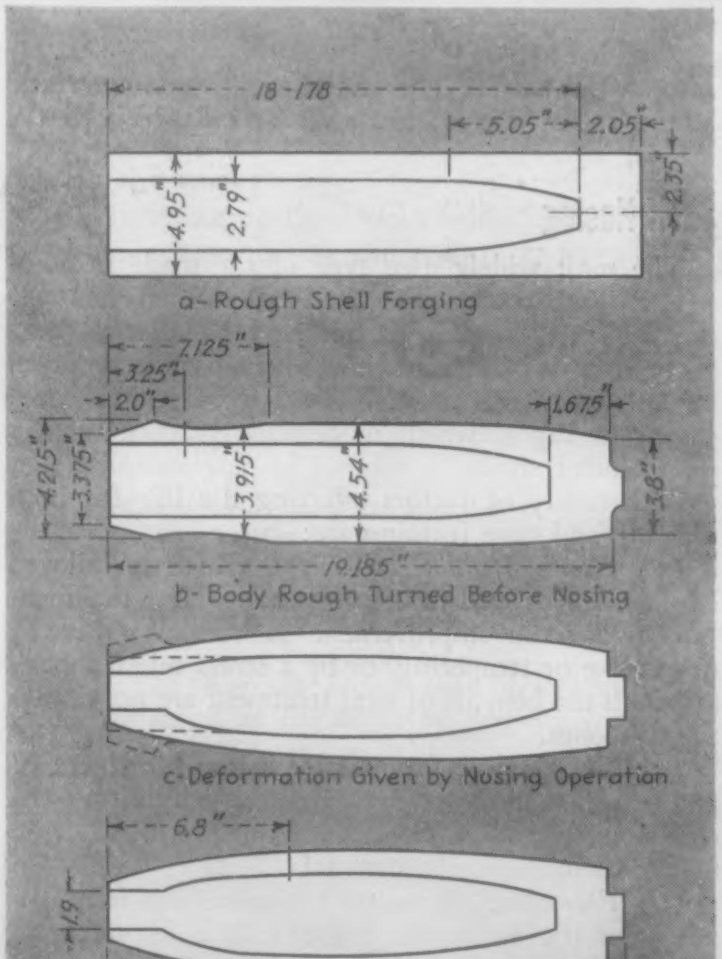
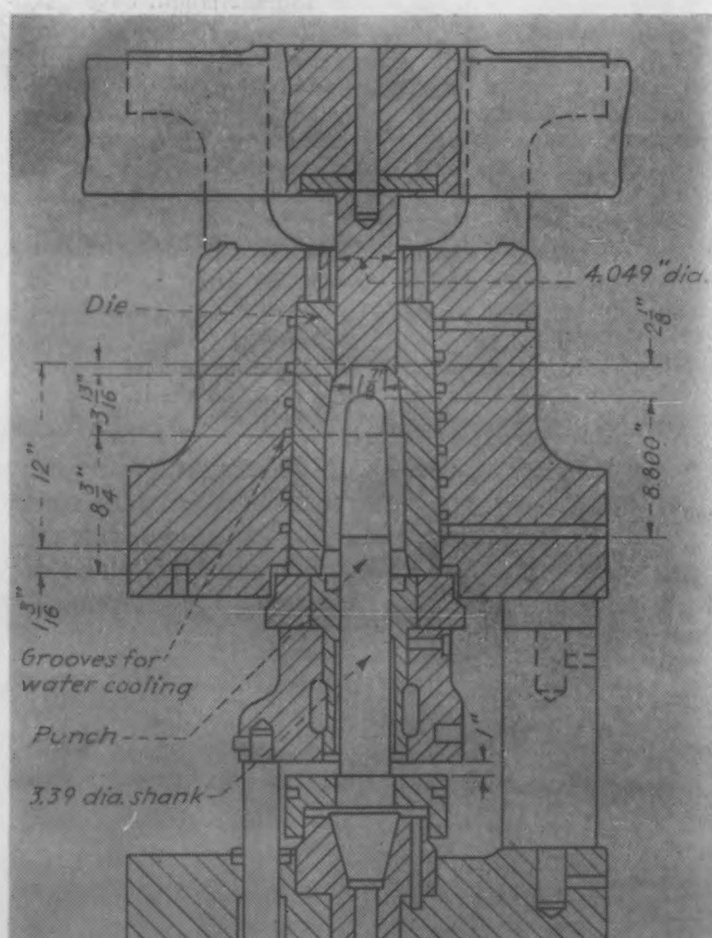


Fig. 3. Various steps in the standard practice for the production of 4.5-in. dia. shells.

Fig. 4. Tool design for inverted method of piercing.



life by placing a water cooled jacket between the die and bolster. Fig. 4 gives an idea of the arrangement adopted.

A comparison of service life of Meehanite dies, between water jacketed dies or dies with no cooling is given by records of piercing dies for 2-in. dia. shells. Die life was as follows:

3,000 to 5,000 shells with water-cooled jackets.

2,000 to 3,000 shells with uncooled dies.

(8) *Die design and thickness:* This cannot be modified by the foundry.

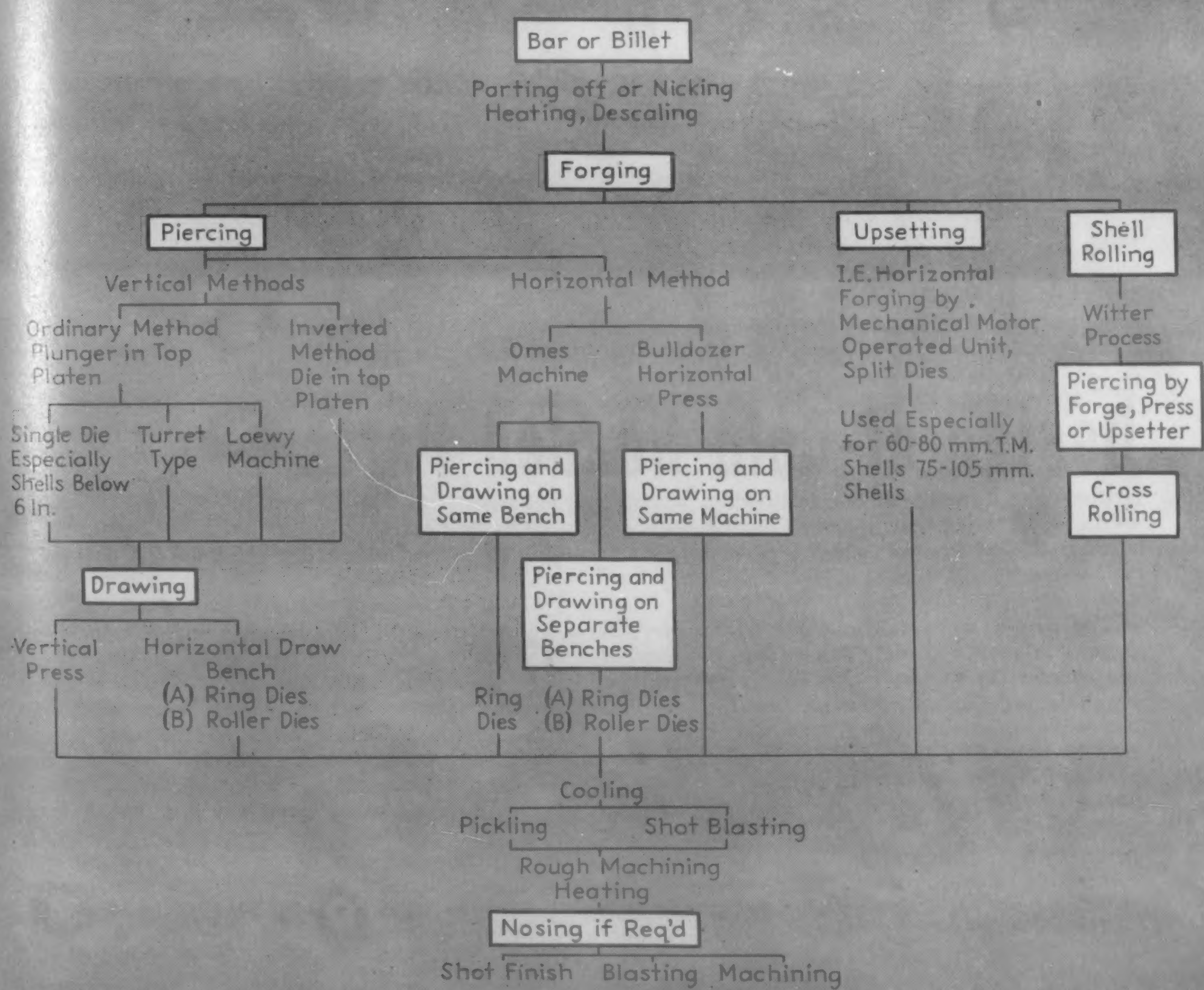
Other Die Materials

In addition to Meehanite, other high duty irons have been developed for piercing and nosing dies to replace steel, and the most successful as far as can be ascertained, compare unfavorably with the life given by Meehanite. The usual problems associated with these materials are to obtain soundness in heavy sections and to adopt correct riser practice when a suitable mix is obtained. These materials are:

1. Chilled iron — The mold for the external die face is built up in chills using medium high-carbon low-silicon irons. Results given are relatively poor.
2. So-called "semi-steel" mixes with and without alloys (usually nickel and chromium) give indifferent results.
3. Nickel-molybdenum-chromium alloy irons — This group under certain conditions has produced good results, according to some reports. Unfortunately no precise confirmatory results are available.

Of all cast materials used Type GM Meehanite seems to have performed the most successfully.

A chart of shell forging precision



Assortment of parts virtually all of which are produced by cold heading. Nearly all are special and involve one or more secondary operations, including a cut or rolled threading.

Design of Cold Headed Parts

By HERBERT CHASE

The design and production possibilities in cold-heading as a metal-working process have not received the attention by engineers they deserve. Useful for countless parts (in addition to the familiar bolts, nuts and rivets) cold-heading is often directly competitive with screw-machine work and hot forging. This article outlines the engineering possibilities and limitations of cold heading and presents specific design-rules for cold-headed parts. Like Hindle's article on sand castings in our April, May and June issues, it is to be a chapter in a forthcoming book edited by Mr. Chase on "Designing for Quantity Production."
—The Editors

COLD HEADING, in common with hot heading, is really a specialized type of die forging. Cold heading is done, however, on special types of forging machines and, in general, by specialists who produce the major proportion of the bolts, screws and rivets manufactured. Although cold and hot heading are basically controlled by the same rules which govern forging (especially that type of forging called upsetting), the type of part is generally much more limited in design, as to shape and size, and, as the heading industry is largely separate from the forging industry, cold heading is considered separately here.

An Upsetting Process

Cold heading is an upsetting process. It starts as a rule with stock of the size of the shank of the piece to be produced. The upsetting creates a head or a flange, usually, but not necessarily, at the end of the piece and commonly of circular section at right angles to the axis of the piece. The head or flange thus produced is usually trimmed to a square or hex shape, though there are many products in which it remains circular.

Modern headers often perform, besides upsetting and trimming a head or flange, what is termed an "extruding" operation in which the end of the shank or even its entire length is driven into a hole of smaller diameter and thereby extruded to that smaller diameter, with a corresponding increase in length. This extrusion is not commonly associated with forging although many forgings are drawn down to less than stock diameter in split dies rather than by driving them into a hole.

Because cold heading is done with great rapidity and high economy, besides requiring no heating of the stock (which therefore is not subject to scaling) and further, is extremely well adapted to making some exceedingly useful types of product, it has found extensive commercial application. It is, in fact, the basic process of the bolt, screw and rivet industry, though (especially in large sizes) it is supplemented by hot heading and in very small sizes or in small quantities sometimes yields to the screw machine, especially where a threaded stem is required or where brass is specified.

Cold heading finds its widest use in the production of bolts, screws and rivets, but it is not by any means confined to such products. Within certain size limits, it is useful in making any part which requires a head or flange or bulb-like portion within its length. It is applicable only to ductile materials. Steels of medium to low carbon content are most used, but ductile alloy steels can be cold headed and many non-ferrous materials also can be cold headed.

Because the material remains smooth and free of scale, the finish of the cold headed part is usually excellent and may even be mistaken for a machined part unless closely inspected. Where a smooth finish without extra operations is required, cold heading is preferred to hot heading, as the hot headed part may have some scale. Dies also become rough through exposure to heat and to cooling water. It is possible to duplicate virtually all cold headed parts by hot heading, except as to finish and as to dimensional tolerances. The converse is not always true however.

Steel Wire Usually Employed

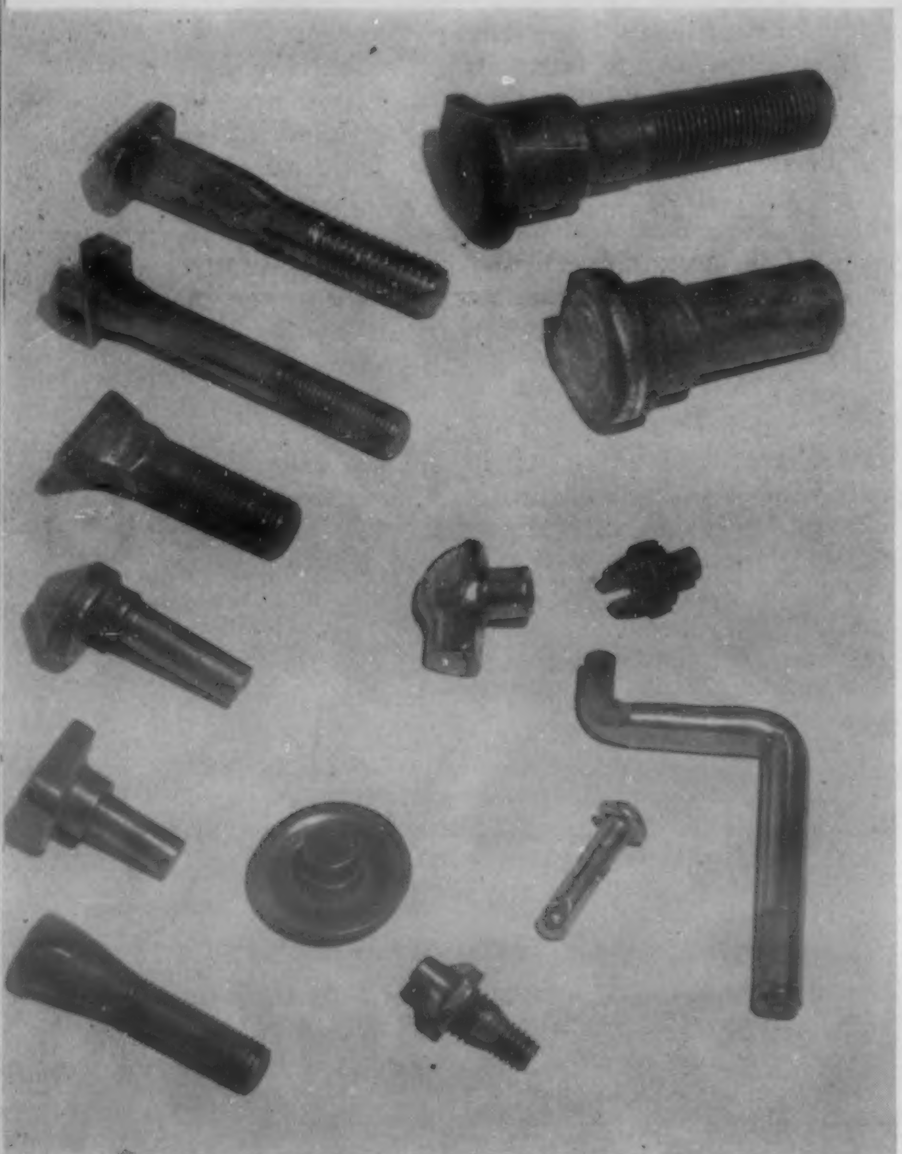
For steel, cold heading is commonly limited to "wire" between 1/8 and 1 in. in diameter and in length (depending upon diameter) from 1/4 in. or shorter to 7 in. maximum. This applies to the automatic cold header. If a hand-fed (or tong-in) machine is used, any length of shank can be had. In ductile materials, especially non-ferrous metals, very small rivets are often made by cold heading, but if the shank must be threaded, it is sometimes cheaper to produce parts below 3/16 in. diameter on the screw machine, especially if quantities are not large, than to make them by cold heading and thread them subsequently, even though the waste in material is much higher. In cold heading, practically the whole of the stock goes into the piece. A waste, usually of 4 to 5 per cent, occurs in trimming the head, if it is not circular, and in stub ends of coils of wire.

Wire rather than rod is used. It is commonly cold drawn and furnished in coils. This stock is fed into the machine through a straightening device and is cut automatically to length. The blank thus formed is held in the die and is struck one, two or occasionally three blows. In the first blow, the head is either given a somewhat conical shape (or may be completely formed) and, if the shank is to be extruded, this may be done in the same blow. Often the work is automatically shifted to one or two other die holes and is struck another one or two additional blows to complete the head. If a third blow is needed, a three-blow header is used. This commonly leaves a head of circular section but the shank below the head may be formed square or depart otherwise from the circular section. Subsequently, the head is often trimmed to a square, hex or other shape by a trimming die. As many as 400 small screw blanks a minute can be turned out, but, as the size increases, the machines run more slowly. Thus, a 1/2-in. long-stroke, two-blow header may produce 80 or fewer bolt blanks a minute.

In no case does the header itself produce the thread, although there are some machines, called Boltmakers, which do turn out finished threaded cold headed bolts. Such machines, however, have separate stations for trimming the head, pointing and threading. In general, when these operations are required, they are performed in supplementary machines. A large proportion of cold-headed products which require threading have the threads produced by rolling. With modern rolling dies, the threads produced are both smoother and stronger (according to foremost authorities) than cut threads and, contrary to some beliefs, closer dimensional limits than for cut threads can be held. Class 2 fits are common and even Class 3 fits are produced successfully. The latter are now being attained in quantity production, especially for aircraft bolts.

Thread Rolling

Thread rolling is a rapid process and results in a thread the outside diameter of which is, of course, larger than the diameter of the blank. If therefore, the outside diameter of the thread must equal shank diameter (as with a cut thread) it is necessary to first reduce, usually by extruding, that portion of the shank which is later threaded. The rolling of a thread causes the metal to flow and form a "grain" which undulates, following the thread contour itself, whereas a cut thread cuts across the grain.



Cold headed parts most of which are rather unusual in design. Most of them are in steel but two of the smaller ones are in brass or bronze.

Although the head or flange formed by cold heading is commonly coaxial with the shank, it need not be. It can be offset entirely to one side or more on one side than on the opposite side. It is even possible to produce cranked parts by cold heading. When a flange is produced, its face can be corrugated or serrated if desired. Bosses can be produced under or on top of the head and flanges or heads can be crowned or made concave. Accompanying illustrations show a variety of cold headed parts which give an idea as to the range of shapes which are feasible but some of these require supplementary operations aside from pointing and threading to attain the special shapes shown.

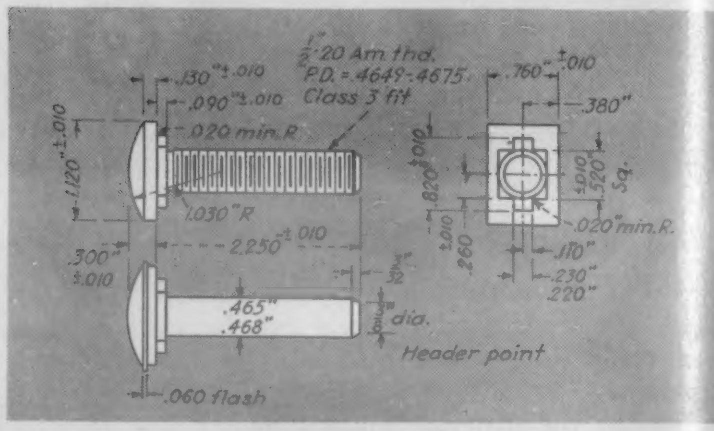
Upsetting and Heat Treatment

The amount of upsetting which is possible in cold heading is dependent in part upon the ductility of the material, the extent to which it work hardens and the types of machine employed. With ductile low-carbon steel, a three-blow header can upset a length of stock equal to about six times the diameter of the stock. As a rule, however, the diameter of head or flange produced is limited to about 3 to 4 times stock diameter and the head volume to that of a length of stock equal to about 4 diameters, unless reheading is done. With materials which are less ductile or which work harden rapidly, less upsetting can be done unless, of course, the work is annealed before reheading operations. Such extra operations, though sometimes warranted, involve higher costs and to that extent tend to nullify the advantages of cold heading.

Nuts and hollow parts of similar shape can be cold headed with a loss of stock no greater than that in the hole to be tapped. It is well to compare the cost of such nuts, however, with those made on special machines which generally employ flat stock and operate without upsetting.

There is a somewhat prevalent but definitely mistaken idea that cold headed parts are inclined to brittleness and especially that the internal stresses set up in cold heading make it easy to break off heads. Certain head shapes, such as those on carriage bolts, must always be stress-relieved by subsequent annealing. Other shapes require no subsequent heat treatment and yet can be relied upon to give satisfaction in service. Experienced makers of cold headed products understand requirements in this respect and their advice should be followed.

Naturally, many materials for cold heading are greatly improved by heat treatment. The cost of such heat treatment is so small in relation to the increase in strength attained that it is amply justified



Fairly typical cold headed part except that the head is oblong and has an odd shape of boss under it. The rolled thread meets Class 3 specifications. Lower view shows part as headed, with point, and before flash has been removed.

economically by savings in material.

Materials and Tools for Cold Heading

Carbon steels with carbon content up to about 0.50 per cent are suitable for cold heading, but SAE 1035 is most commonly employed in the higher carbon range. Cold drawn wire is ordinarily used.

Many alloy steels, such as SAE 3135 and SAE 2330 are employed for cold heading. Others now in common use include SAE 1020, A 4037, NE 8637, NE 8739 and SAE 4140. Where stainless steels are required the 18 and 8 type is sometimes

chosen. The straight chromium (12 to 15 or 17 per cent Cr) stainless steels are also used.

Non-ferrous materials often cold-headed include 17S and 24S aluminum alloys as well as certain brasses and bronzes. Non-ferrous alloys are employed chiefly where special types of corrosion resistance, a special color or appearance or good electrical properties are needed or, in the case of aluminum alloys, to reduce weight. Costs are naturally higher than for carbon steel or for low-alloy steel and strength is commonly much inferior to steel.

Ductility is a primary requisite for cold heading and steels of relatively low sulphur content are needed. These are quite different from the requirements for screw machine stock in which ease of machining is a primary requirement and sulphur content is relatively high, as a rule, for this reason. Since there are many products which can be made alternatively either on the screw machine or by cold heading, however, it is frequently good practice to specify alternative steels, one suitable for the screw machine and one intended for cold heading. Prices and delivery dates are then determined for both types of product and that which affords the better combination of delivery and economy, is purchased, especially where, as is often the case, there is little to choose in respect to finish.

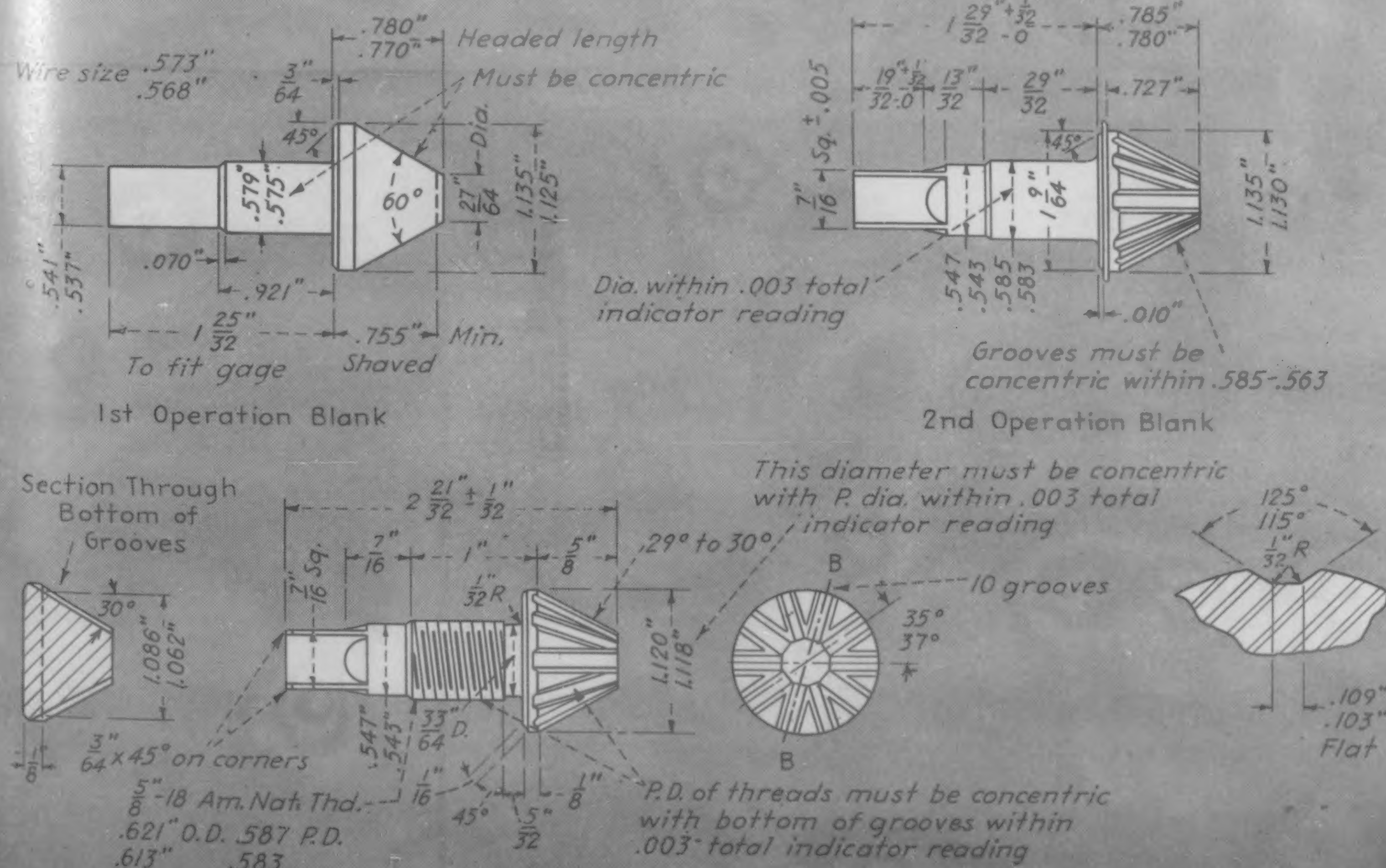
Heading dies and punches are required, of course, to produce cold headed parts and special tools are sometimes needed also for supplementary operations. The cost of such dies and tools (unless stock tools happen to be available) is commonly too great to warrant making them unless this cost can be spread over a "production quantity" of parts. Once dies are made, however, they can turn out very large numbers of cold headed parts at a very low cost per part.

Special vs Standard Headed Parts

It should be remembered, however, that companies specializing in cold heading always have on hand dies and other tools for standard headed parts in a considerable range of sizes and, if any of these can be made to serve a given purpose, the cost of special tools can be avoided. There are, also, cases in which standard parts produced by cold heading can be altered by some inexpensive secondary operation to make them serve special purposes. Then, too, although the standard product may have a hex or square head, the headed *blank* usually has a round head which can be trimmed, if necessary, to a special shape, thus making use of standard die except for head trimming.

Moreover, a blank produced in a stock die can be threaded in different ways, as the production of

Though unusual in shape, this part is readily cold headed, including the radial grooves in the head. Several of the dimensions are held within close limits. The thread is rolled and outer end of shank is square.



the thread is usually a separate operation. Rolled threads, commonly used on cold headed products, require that the portion of the shank to be threaded be smaller than the outside diameter of the thread and the diameter differs for each pitch of thread. This may make it necessary to reduce the shank diameter by shaving, milling, grinding, or extrusion before the thread is rolled. Cut threads are produced on shank diameter regardless of their pitch.

If such possibilities are kept in mind it may be easy to produce a special product from a standard blank with little or no extra cost for special tooling. In all cases, however, it is better to specify a standard form and fit of thread and, if possible, a standard head, than to call for specials where they are not truly necessary.

Reference to the standards set up and to the parts listed by the American Institute of Bolt, Nut & Rivet Manufacturers often makes it possible to specify a standard product readily available either from stock or from stock dies that will meet requirements without resort to a special design for which special dies are needed. But there are many cases in which special dies are fully justified.

Cold headed parts are made, however, to a definite length in a given die and this length cannot be above a fixed maximum in a given automatic machine (as it can be in hot heading) to meet varying requirements. Naturally, a cold headed part which is too long can be shortened in a separate operation and may, even then, cost less than to provide a special die.

In automatic cold heading, the maximum blank length is determined by the stroke of the machine, and thus cannot be altered for that machine. The following are the maximum lengths of blank for a series of long-stroke, two-blow machines of a well known make for different stock sizes:

Stock dia., in.	1/8	1/4	3/8	1/2
Max. blank length, in.	2	4	5 1/2	7

Naturally, the maximum length of the headed part is shorter than the maximum blank length, the difference depending upon the amount of material upset into the head or flange produced. Where the length needed exceeds the maximum for a given machine, a larger machine is often employed. Thus a 1/4 x 6-in. bolt commonly is produced on a 3/8-in. machine.

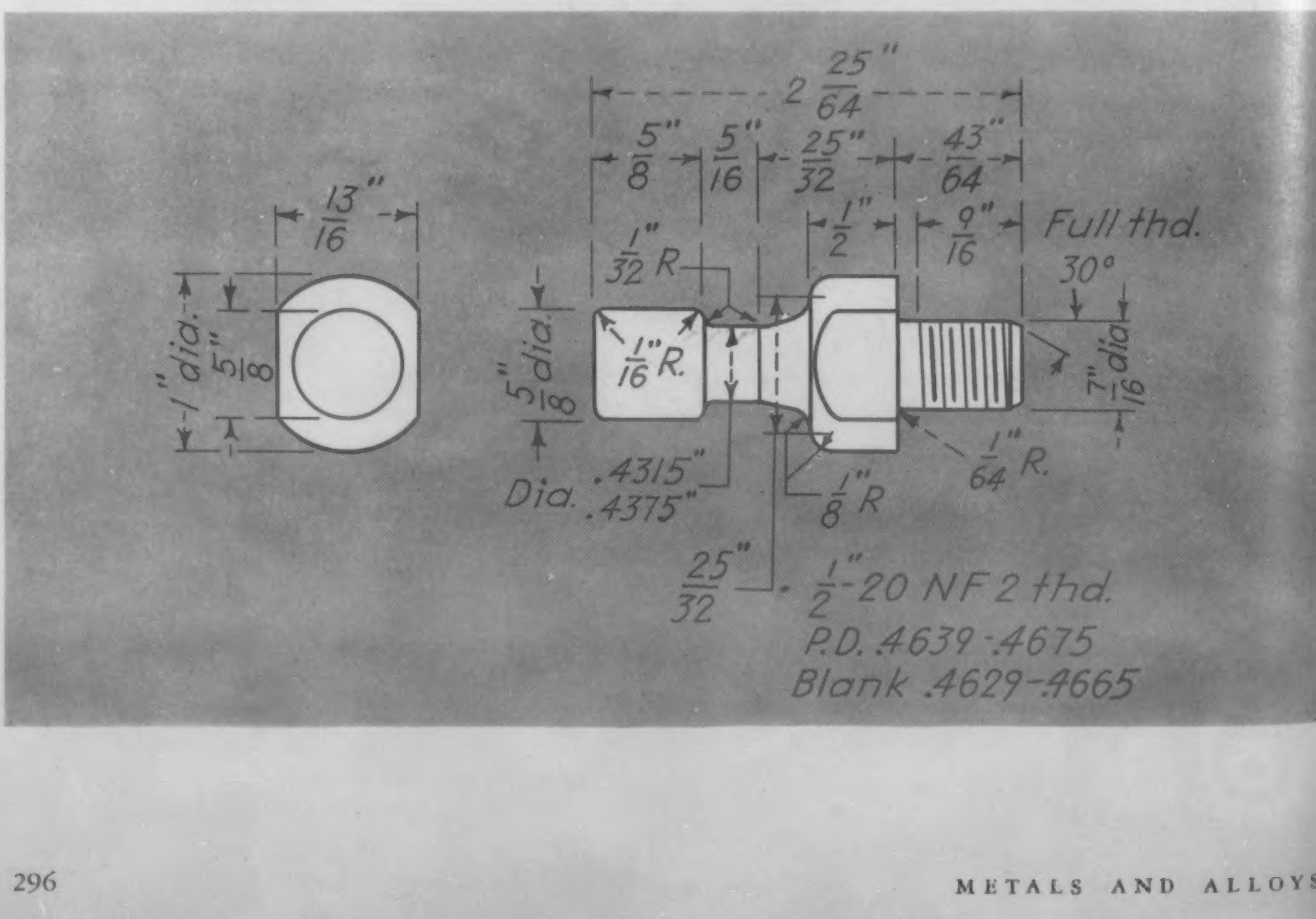
Design Considerations

As far as the author is aware, no rules for the design of cold headed parts have ever been formulated heretofore. Those which follow may appear self-evident. They are not all-inclusive and some are subject to exceptions. All are intended as a guide in determining what should be done and what avoided *when the objective is a product of minimum cost* consistent with ability to perform the function intended.

As with other products dealt with in this book, it is well to consult with producers of the part intended for cold heading before the design (if it departs from that of the conventional cold headed product) is so far advanced that changes are not feasible.

In most instances, the rules refer to the part as

A part of this shape is readily blanked by cold heading but the necked portion has to be turned subsequent to heading and the flats on largest diameter are trimmed. Despite these supplementary operations the part costs less and requires less material than if produced by screw machine from alloy steel.



produced in the cold header *without* the supplementary operations which follow (in the average case) to complete the part. Naturally there are many operations, such as re-heading, threading, drilling, pointing, shaving, slotting, sawing, turning, milling and grinding, which may be performed in secondary machines and which no set of rules can cover. When the object is minimum cost, conservation of material or quick delivery, no operations not essential in the finished product should be called for.

In most cases, the producer of cold headed products has the necessary secondary machines to turn out a finished product and the designer need not, as a rule, be concerned as to how the operations are performed as long as the finished product meets requirements, provided, of course, he does not call for operations which are unnecessarily expensive. In many cases, producers of cold headed parts have, in addition, equipment for hot heading and they may

Etched section of cold headed rivet. The flow lines indicate how the metal is displaced and why the head is stronger than if the rivet was cut from bar stock without upsetting.

elect to use it in preference to the cold header if economically expedient unless, of course, some special requirement prevents this.

As explained in another chapter, hot heading is likely to cost somewhat more per piece than cold heading, hence it is commonly used only when cold heading is not feasible or when tooling cost will be less, for the quantities ordered, if hot heading dies are on hand. It should not be forgotten, however, that many parts which cannot be produced by cold heading are easily and economically produced by hot heading, including many in which the amount of metal to be gathered by upsetting is much greater than can be gathered by cold heading.

While the designer usually need not specify the machines and methods used in making a given part as long as the part as delivered meets his specifications, he should design the part, as far as he can, to take advantage of the economies of cold heading (if he considers it suited for such production) and make sure that, if it is not produced by that method, it still meets his needs.

Accompanying drawings and other illustrations of cold headed parts serve as an indication of certain classes of work done by cold heading (with such secondary operations as are needed or are usual in these cases) and may serve as a guide in designing similar parts. It is not feasible to go into greater detail in a brief chapter on this subject, but the appended rules should prove useful as a guide in designing cold headed parts.

Some General Rules

1. Design for the smallest diameter of stock, suited for cold heading, which will meet requirements at moderate cost.
2. Limit the amount of metal to be upset to the minimum which will meet requirements, using conventional head styles or types, if possible.
3. Specify carbon steel of cold heading grade unless specific requirements necessitate another type of material or unless it is certain that some other material will prove lower in cost or will justify such higher cost as may be involved.
4. Specify a head or other upset portion of the minimum diameter which is consistent with requirements and preferably one not over three to four times stock diameter.
5. Do not specify a special head, a special thread or a special length if requirements can be met with *standard* heads, threads and lengths.
6. If a special design is essential but requires only slight departure from a standard headed part, determine whether alteration of the standard part will meet requirements economically without necessitating a special die.
7. Never specify a square inside corner or sharp junction between head or flange and shank if a small radius will meet requirements.
8. Do not specify an over-all length greater than commonly supplied for a given size of stock unless assured of its availability by cold heading (or unless hot heading will meet requirements).
9. Permit rolled threads to be supplied unless the manufacturer finds it more expedient to furnish a cut thread.
10. When a shank requires a stepped diameter, provide for a generous radius or a taper at the step, unless extra cost for machining a square step is warranted.
11. When a taper is required on any part of the shank, its larger end must be nearer to the upset portion than its small diameter, that is, the taper must be outward, unless special machining is justified.
12. When a shank must have some portion which is not circular in section, minimize the length of this portion and do not specify sharp corners.
13. Never specify narrower dimensional limits than are essential or than are to be held in mating parts.
14. Unless wrench holds or other flats on edges of head or some odd contour is necessary, specify a head which is circular, as small in diameter as feasible and neither too thin (less than 3/8 of diameter) or too thick (more than 3/4 of diameter).

Spinning Brass Primer Tubes

If ingenuity alone could win the war, we'd have finished off our enemies the week after Pearl Harbor. Typical of the many clever innovations that American engineers have introduced in the "methods" field is the Hill process for forming small brass primer tubes (and other cylindrical parts of other metals) by spinning. The process, described up to the censorship limit in this article, is said to save time, labor, machines and material. It should be of interest to both the production and design engineer.
—The Editors

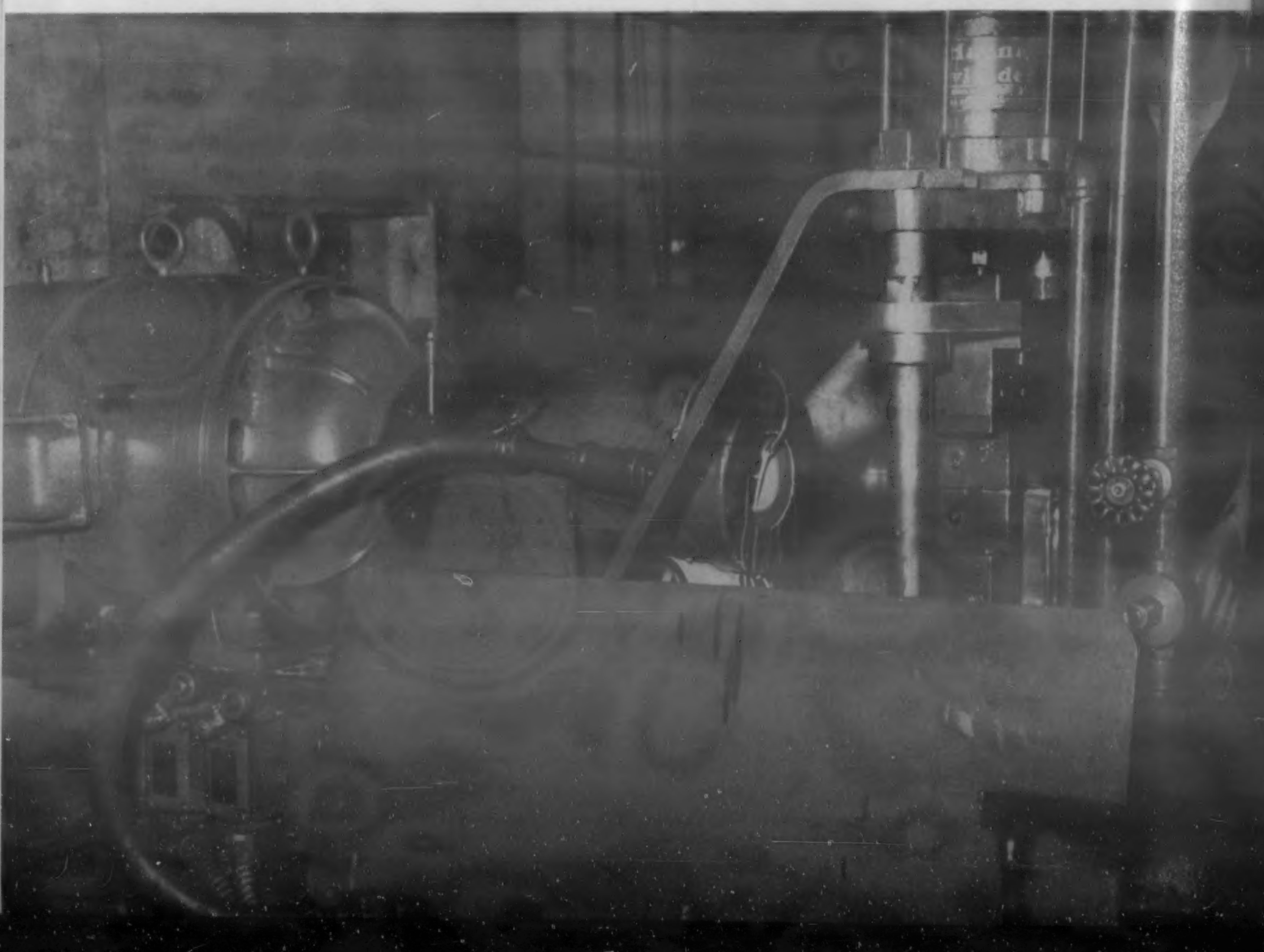
by HAROLD A. KNIGHT
News Editor

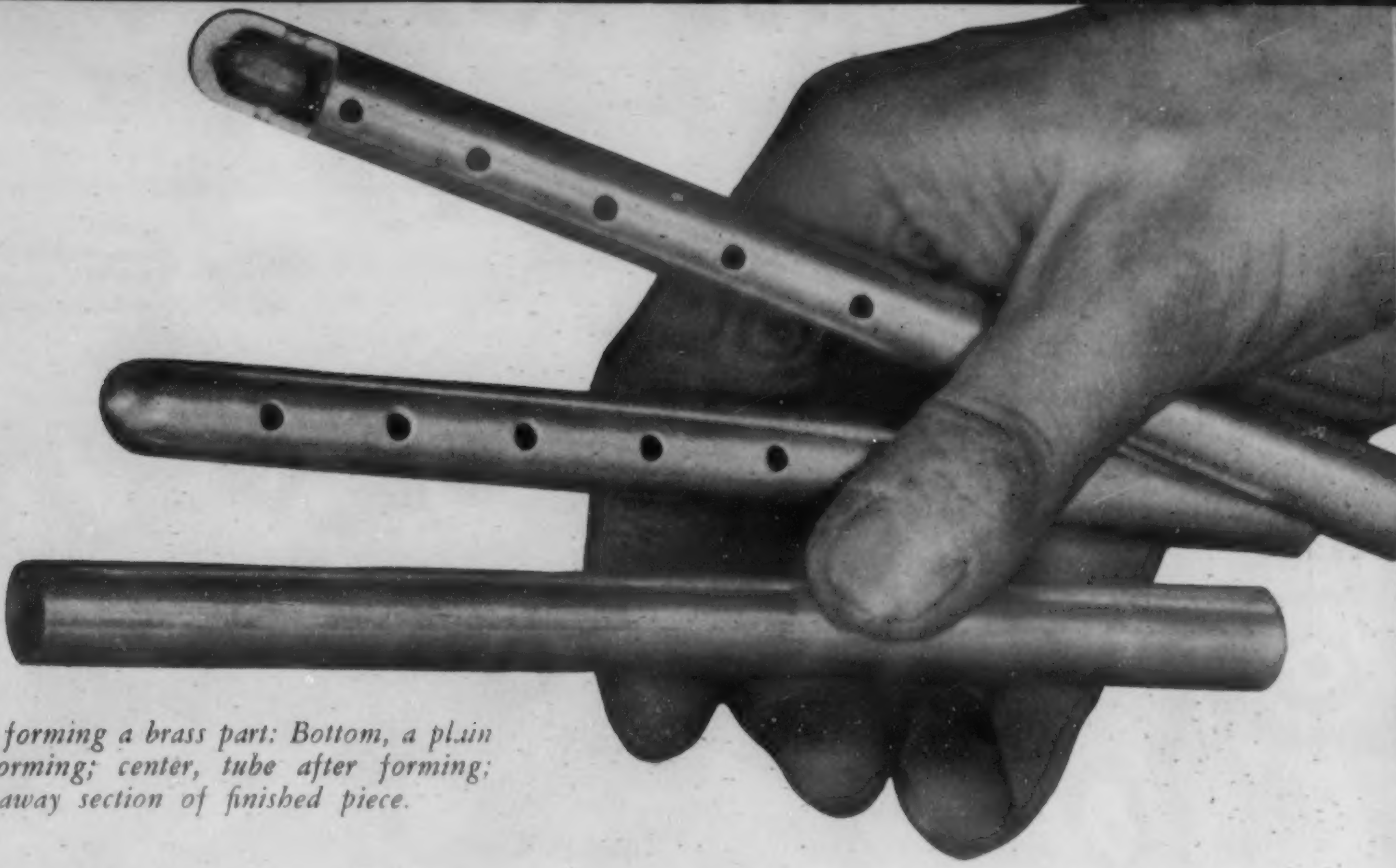
WHIRLING AND SPINNING OPERATIONS in metal forming have become more prominent during the war era. Centrifugal castings are on the march; aluminum airplane cowls are now being spun at some plants, an adaptation from the spinning of aluminum giftware such as cheese-and-cracker dishes.

Now comes a process developed by Walter P. Hill, development engineer, Wolverine Tube Div., Calumet and Hecla Consolidated Copper Co., Detroit, whereby the open end of a tube is forced into a high speed steel die, revolving at about 1100 rpm., which in a few seconds forms a dome-shaped closed end of any desired wall thickness, with the spun metal being more ductile than the original tube as a result of the self-annealing feature of the process.

Fourteen companies have been licensed by Wolverine to use this process for making small primer tubes, used in the firing mechanisms of all the millions of large shells produced in the United States. Not only are these tubes sounder, simpler and more efficient than the somewhat complex components previously manufactured, but the costs of manufacture are low by comparison with older methods. These particular items are made of 2-and-1 leaded brass. Any brasses can be worked, right on through to pure copper, as well as aluminum alloys and various ferrous metals.

The large spinning machine with hydraulic feed. The tool has just finished forming the copper tube immediately below the operator's right arm.





Three steps in forming a brass part: Bottom, a plain tube before forming; center, tube after forming; top, cut-away section of finished piece.

Operating Features

Pilot machines in the Wolverine plant are mostly manual-operated and so simple and easy that women can run them. In the same plant semi-automatic machines have hopper and magazine attachments which speed production. Any machine that can impart relative rotation to tool and work can be adapted to this spinning process. Naturally, the tool and work must be allowed to come together so that the forming can take place, but the job can be done on a lathe, screw machine, spinner, drill press, or a specially designed machine. Some of the licensees have more efficient machines than Wolverine. Production as high as 2500 per hr. has been reported.

Scrap loss is as a rule very low, usually less than

Spinning operation — finished brass tube shown at the right and the forming tool at the left. In this case, the tool does the rotating, although it is shown stationary in the picture.

One of the primer tubes about to be inserted into a shell by Walter P. Hill, the inventor of the process described.

a half of 1 per cent from the spinning operation. On some jobs there is virtually no scrap. There is no heating (annealing) necessary in connection with this process. The metal being formed is self-annealed and without application of any external heat. The friction in the operation develops 800 to 1400 deg. F., depending on the metal. As a result of this high friction-generated temperature, the tube end is annealed or recrystallized which gives a more ductile metal for easier working.

A feature of the die is the open space, expansion gap or relief area, comprising perhaps 20 per cent of the die's area. This allows the metal for an infinitesimal period to expand and bulge out the gap, being forced again into shape as it reaches the solid portions of the die. Presumably this gap prevents the metal sticking or binding in the die and allows gases and heat to escape. Lubrication is used as a coolant in high speed production, although some of the more simple operations can be done dry without lubricant.

Any good grade of high speed steel can be used to make these spinning dies and the tools have almost indefinite lives. Some tools have already produced hundreds of thousands of pieces and are still going strong. They can be reconditioned easily by "breaking" the sharp edges of the relief area. Many of the tools, or dies, that are being used successfully have a hardness of 57 on the Rockwell C scale.

Design Factors

In the pilot plant, tubing up to 3-in. diam. has been processed successfully and the inventor does not know what the final limits are. Dimensions can be held to within plus or minus 0.002 in. on the diameter or general shape. In some cases closer tolerances can be held without further machining. A very important feature of this process is that despite the heat generated during the forming, the finished surface is usually comparable to a machined surface and presents a fine finish.

Wall thickness at the spun end can be held uniform from piece to piece and the thickness depends on the length of the feed of the machine. The tolerance here can be held as close as that of the mechanical stop.

The inventor states that the physical properties of the original tube "may be almost anything." The spinning process has been applied successfully to materials all the way from full hard to dead soft, with the corresponding tensile strengths. The grain structure of the spun metal is fully re-crystallized with a small grain size. This seems to be the result of the heat and pressure of the process.

Sponsors of the process state that there are several factors which make it economical. These may result from savings in time, men, machines or material. These savings of course are figured in relation to what it costs to achieve a given result by some other method.

Some of the advantages of this process are: Simplicity of the set-up, low tool cost, high production rate and the elimination of several operations previously required to make the same munitions component. By this process the spun end does not necessarily need to be closed. Thus a mandrel can be inserted and, instead of closing, the diameter of the tube is merely reduced, as in a cartridge case.

Contrasts between the old way of making brass primer tubes and the new are extremely sharp and interesting. By the old method one started out with yellow brass tube, 9/16 in. O.D. and round brass rod, the latter for a plug. At least seven operations were involved as against one operation and one material, a yellow brass tube, in the new.

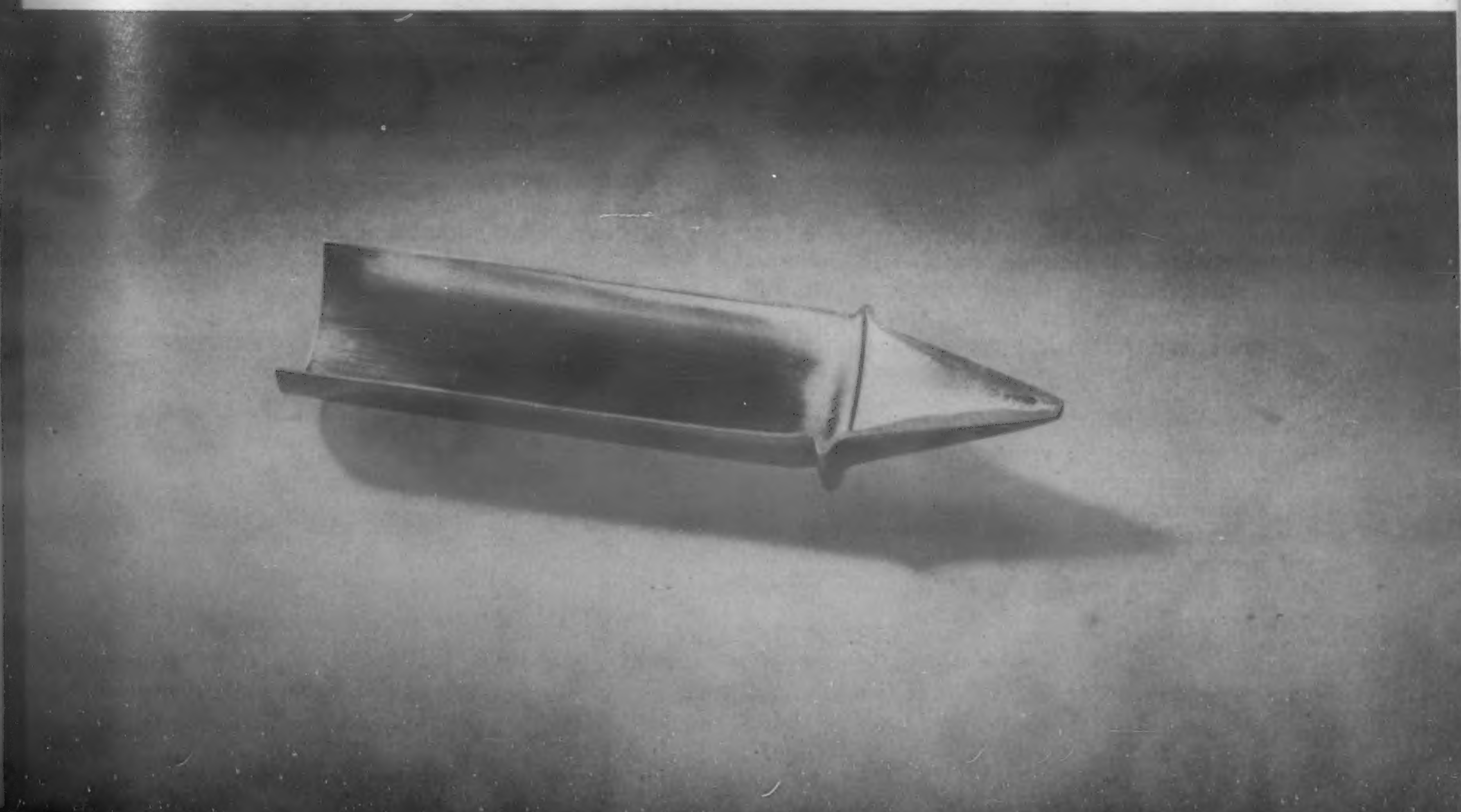
The former method dictated: (1) Drill and counterbore end of tube; (2) tap end of tube; (3) 100 per cent inspect thread; (4) make plug complete on automatic screw machine; (5) assemble plug; (6) spin or roll end to stake plug; (7) 100 per cent inspect staking operation.

The softening effect of the spinning was studied on a typical primer tube, 0.540 in. O.D., seamless 2 and 1 leaded brass, that had been closed on the end. Readings were Rockwell (superficial) 30 T scale. The reading on the main tube portion, well away from the spun end, was 72-71. Coming close to the end, the reading was 50-52; still nearer, 47-45; again nearer, 40; finally at the tip it was 30. Photomicrographs also bore out the hardness readings in showing the gradual change from half hard to soft.

Though the main body of the processed tube is hard and the end soft, due to the spinning, the complete part can subsequently be annealed to achieve practical uniformity. Moreover the end can be converted back to original hardness by cold-working operations.

When pressed for a definition of his process the inventor calls it "a process for hot-forming, by spinning, to a predetermined shape without the application of external heat."

This is a complete closure in brass, conical, with bead formed afterward. By the old method of forming, 3 materials and 8 operations were necessary; by the new, one material and two operations: Spin end to point and form bead in punch press. The former assembly involved the tubing, a pointed casting, a screw and solder; also machining, drilling and tapping.



Arc Welding of Magnesium Aircraft

Here is the complete, detailed engineering story of the recently developed method of arc welding magnesium aircraft structures, using a helium atmosphere (the "Heliarc" process) — how the process is performed, what its use means to aeronautical engineering and how it fits into today's and tomorrow's design and manufacturing picture. The report won for its authors a prize in the Lincoln Foundation's recent $200,000 competition. —*The Editors*

DURING THE LAST DECADE, monocoque, or semi-monocoque aircraft structures, in which all, or a substantial portion of the structure load is carried in the skin, have come into general favor among airplane designers. A survey of modern aircraft finds few, if any planes in which wings, fuselage, or tail structures are not substantially based on the stressed skin principle, and many modern airplanes are almost solely dependent upon this principle for their long service life and rugged structural integrity.

Pioneered more than 25 years ago, the airplane fuselage fabricated from glued and nailed wooden strips was the first element in which the stressed skin principle was used widely with success. Beginning within the last 15 years, the same ideas have been applied with great advantage to steel, aluminum, and magnesium parts, while the newer synthetic binding resins have been utilized with excellent effect to improve the wood-base structures of the pioneers of monocoque.

The best and most efficient materials for use in pure monocoque construction are unquestionably those having low specific gravity and relatively high modulus of elasticity, in order that the material may have high compressive strength before buckling occurs. On this basis certain plywood combinations, if uniform in quality and readily available in quantity, would no doubt prove of the best structural value.

Unfortunately, however, nature controls the quality of tree growth, and the quantity is very severely limited by the number of suitable trees already in existence at a time of emergency. Those with sufficient summers to remember World War I can vividly recollect the shortage of suitable airplane lumber, and the resultant skyrocketing prices thereof, even as a result of the comparatively insignificant aircraft production of that day, and it is thought that even the most enthusiastic proponents of "plastic" (plywood) planes do not recommend their processes as applicable to more than a small portion of the present aircraft program.

On the other hand, metals are available (though rationed as to use) in very much larger quantities. Their qualities can be kept exceedingly uniform by comparison to those of a grove of trees, and production increases are dependent solely on men's energies and ingenuities.

Metals for Stressed Skin Structures

These facts led the authors, early in 1940, to choose the field of metals in a research program directed toward obtaining more efficient stressed skin aircraft structures. While it was realized that the miracle of the organic chemist's test tube might one day produce a "true" plastic of outstanding physical qualities, nevertheless the need was immediate, and there were available at hand metallic alloys having great promise.

Steel. In metals, as in other substances, low specific gravity in combination with high modulus of elasticity offered the most attractive field of research. Stressed skin structures of steel have been commonplace in other fields of endeavor, but when designed to weight limits acceptable for modern aircraft, the result was almost always a comparatively thin sheet operating within its buckling range, and "stiffened" by a multitude of small formed beams, ribs, or stringers, spot welded or riveted to the main cover sheet. Here the cost of forming, handling, tooling and assembling becomes a serious if not prohibitive factor, although very efficient steel structures of a semi-monocoque type have been designed and built.

Aluminum. As the best known and most widely developed of the so-called light metals, aluminum and its alloys have come to be nearly universally used for most external aircraft coverings.

Pioneered in European countries, at first largely to carry shear and torque loads as a wing and fuselage covering, aluminum has become within the last 10 years an indispensable and major element in the designer's field of materials, and is used, reinforced by strips, extrusions, beads, or ribs, for the major portion of the structure on most military and transport aircraft that fly today. In the earliest examples aluminum was used in corrugated form in an effort to increase the effective thickness, while later, smoother surfaces were demanded to reduce the excessive drag always related to external corrugated skin.

Flat aluminum sheet, however, must be regarded as having a higher density than desirable, and is rarely used without some internal stiffening of strips or corrugations. Likewise the comparatively thin cover sheets buckle within the range of normal flight loads,

Fig. 1. A typical microscopic view of an etched Heliarc welded seam in Dowmetal J-1 magnesium alloy.

ft

Structures By V. H. PAVLECKA and JOHN K. NORTHROP

Chief of Research and President, respectively, Northrop Aircraft, Inc., Hawthorne, Cal.

as can readily be seen during a short ride in a modern transport. Also, while spot welding has been developed to an excellent degree of reliability for many of the aluminum alloys, an exacting technique is required in its use, and many joints must be made where the physical limits of spot welding equipment do not permit its use.

And so we find most modern aircraft to contain from 100,000 to over 1,000,000 rivets, each requiring a layout, at least one and often two punching or drilling operations, and, in a majority of cases, the attention of two operators to drive. Then comes an individual inspection of each rivet which, if not successful, requires replacement and the expense and delays attendant thereon.

A further stimulus to the search for better, cheaper, and smoother aircraft structures lies in the fact that great advances in the science of aerodynamics have proven conclusively that the effects of rivet heads (even if countersunk), local buckling, and general surface irregularities are much more detrimental than previously believed, and that the aerodynamic form of the external surface must be smooth, uniformly finished, and without local buckles if the minimum drag is to be achieved.

Magnesium Alloys. All of the above considerations led, early in 1940, to a further investigation of available materials and methods of fabrication. As the lightest of generally available structural materials, magnesium and its alloys soon proved most attractive. Less than two-thirds the weight of aluminum, and not much over one-fifth as heavy as steel, such materials have a relative stiffness, for a given weight of 2.5 times that of aluminum and 19.5 times that of steel.

First developed in the United States by the Dow Chemical Co. as a relatively useless by-product, Dowmetal alloys have recently assumed greater and greater importance in the manufacture of aircraft. Available in cast, extruded, forged and rolled form, these materials have first been used largely in engines, wheels, other accessories and secondary structures rather than in primary parts, although usage in Germany (where especially attractive) has been more widespread than in the United States. The facts that the production of magnesium is rapidly expanding, that the sources are inexhaustible (9,000,000,000 lbs. in each cubic mile of sea water), and that next to beryllium it is theoretically the best possible material for simple metal monocoque structures, have assured its widespread use in aircraft.

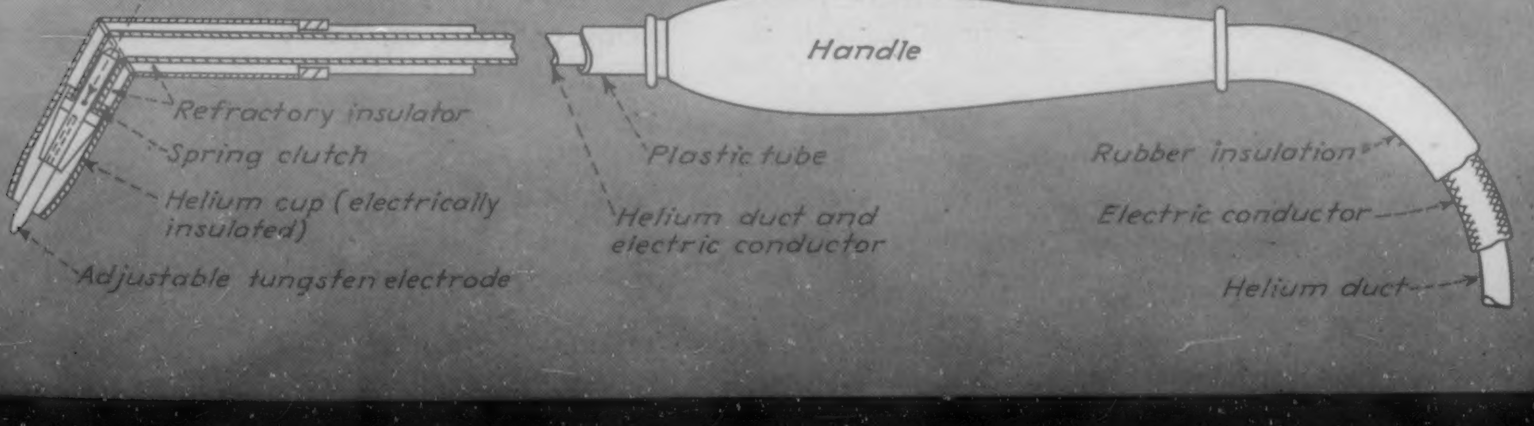
Fabrication Methods for Magnesium

Once a decision was reached as to the material choice, attention was at once turned to methods of fabrication. Magnesium had previously been spot welded and gas welded successfully. However, rivets of magnesium alloy work-hardened so rapidly during driving as to prove impractical, so that other materials had to be used for rivets in the assembly of magnesium parts. Also the ideal surface smoothness for which we have been striving cannot be obtained by lap-joints, whether riveted or spot welded, particularly in view of the comparatively thick sheets which are employed in pure monocoque design.

Gas welding was available as a means of attachment, but gas welding could only be accomplished under the protection of a heavy flux, due to the extreme affinity of magnesium for oxygen and nitrogen, particularly at elevated temperatures. And, unfortunately, the successful fluxes available were all of an extremely corrosive nature, and rapidly attacked the resultant magnesium assembly if the slightest contamination remained in the weld.

After many disheartening attempts, the search led finally to the consideration of electric arc welding which had previously been considered impossible on magnesium. The first experiments led to many small magnesium fires. An amazing number of preliminary experiments can be imagined, when all possible variations in alternating and direct currents, polarity, types and materials for electrodes, fluxes, and blanketing gases were tried. It is the belief of the authors that all the unsuccessful combinations were attempted not once but many times. Fluxes were soon abandoned from considerations of corrosion, and numerous efforts were made to weld, using various types of blanketing gases either in an enclosed space, or allowed to flow over the work from the vicinity of the electrode.

Fig. 2. A typical torch assembly.



The first glimmerings of success occurred when the arc was struck between the work and a magnesium electrode which was supported in a hollow receptacle through which helium, under low pressure, was allowed to flow into the weld area. With this arrangement, however, the control of the flow of material to the weld was erratic and blobs of the electrode appeared in a disheartening array along the weld. Various refractory materials were then tried for the electrode, and when the research program reached the stage where a tungsten electrode was used in a helium atmosphere, success instantly crowned more than a year of experimentation and the Heliarc method of welding was born.

Helium Arc Welding of Magnesium

Basically, this method of electric welding, useful with all standard direct-current welding machines, consists in striking an arc between the work and a tungsten electrode, simultaneously feeding helium gas to the weld area through an annular nozzle surrounding the electrode, and feeding the additional weld material needed for the joint into the arc from an uncoated welding rod of substantially the same material as the work. Reversed polarity is used, i.e. the current flows from the work to the electrode. The flow of helium, fed to the work area at 0.25 to 0.5 lbs. per sq. in., is controlled by a valve on the torch handle which is opened by the operator just before the arc is struck, and held open during the welding process. The arc is very quiet during a Heliarc weld — there is no tendency to sputter or throw materials from the weld as is sometimes the case with other processes; and a very uniform, high quality weld can be obtained by an average operator after short practice.

This method of welding will shortly be made available to the public under license, and while it was developed primarily for use on magnesium, it will probably find extensive use on alloy and stainless steels, where the results seem superior to those obtained by any other known method. The quality of the weld is high, the strength of the joint varying from 80 to over 100 per cent of the parent material, depending on the alloy and welding conditions, and there seems to be no limitation in the type of joint that can be made — butt, lap, tee, corner, and angle joints being made with equal facility.

The helium blanket completely eliminates the use of any flux in the joint, and while minute quantities of tungsten are present in the joint, there are no adverse corrosive effects therefrom. Actually, the weld appears somewhat more corrosion-resistant than the parent metal, there being a slight electrolytic balance which causes corrosion, if it appears at all, to be present in the sheet adjacent to the weld rather than in the weld itself. This effect is so small, however, as to be negligible for all practical purposes. Welds can be made with equal facility in rolled, cast, extruded, or forged parts, and some experiments have been made where cast and rolled or extruded parts have been welded to each other.

The seams, fusion welded by the Heliarc process, are distinguished by their metallurgical purity, homogeneity, and absence of inclusions. Fig. 1 shows a typical microscopic view of an etched Heliarc welded seam in Dowmetal J-1 magnesium alloy. From it will be apparent the close-grained, highly packed fused metal, which has approximately 2 per cent higher density than the parent metal, acquired in the welding process; it will be particularly noted that the fusion boundary is gradual and deeply penetrating.

A typical torch assembly is shown in Fig. 2. Any good DC welding equipment is suitable for use in the Heliarc method, and the Heliarc process has a particular attraction and importance in the United States, since our country is today the sole producer of this gas on a commercial scale and in large quantities, and also because considerable reserve volumes of it have been accumulated in the last six years. For those interested in the more technical details a bulletin has been prepared which can be obtained on request.

Design Considerations and Structural Details

It was reasoned that the application of magnesium alloys to aircraft construction could be accomplished along two different principles. The first and most obvious way would be to design a magnesium airplane structure for maximum weight reduction. This conception was studied with the conclusion that the undesirable physical properties of magnesium alloys (rapid strain hardening, corrosion, etc.) would probably not permit a greater weight saving than approximately 10 per cent over a comparable structure made of aluminum alloy. In view of the established fact that only approximately one-third of the weight empty of a modern military airplane is the airframe or structural weight, the total weight saving would, at best, amount to some 3.5 per cent of the empty weight of the airplane.

This slight gain was judged to be overbalanced by the necessity of an extremely careful and expensive design which would require the use of relatively thin gages of magnesium alloy sheet. It was therefore decided to favor, in the design of these wings, the perfection of the aerodynamic shape and simplicity and low cost of structural construction. These two qualities, in the estimation of the authors, are more important than small weight savings, provided they can be gained without increase of commonly accepted structural weights.

The design criterion adopted was, therefore, that superior and less costly magnesium airplane structures could be designed and built for the same weight as the present more expensive aluminum alloy riveted structures.

The wing design illustrated was not made analytically by taking the weight of the present BC-1 aluminum alloy riveted wing and reapportioning it to the various structural components of the magnesium alloy wing. On the contrary, the Heliarc welded magnesium alloy wings were designed synthetically from the test experience and data already accumulated, and from the calculated loads acting on the wing. These considerations determined the proportions and distribution of the structural component parts and also the type of welding seams to be used in connecting them.

The calculated loads were based on the same design factors as used in the design of the riveted aluminum alloy wings already in service on BC-1 airplanes. Before the construction of the wings was begun, a very detailed weight analysis was made which indicated that the weight of the completed welded magnesium alloy wing structures should be approximately the same as that of the aluminum riveted wings; this has been approximately confirmed by actual weighing of the finished structures.

The whole wing structure is composed of only two basic elements: The sheet, forming the monocoque shell; and extruded sections, forming the internal structure. The versatility of arc welded construction made it possible to limit the number of various extrusions, such as "tees," angles, etc., to no more than four different sections. Furthermore, the preparation of the profile sections and sheets was greatly simplified, because flanges for riveting, and elaborate templates for the shaping of parts and the coordination of multitudes of riveting holes, were no longer necessary.

Manufacturing Problems

In almost all welding a certain amount of shrinkage distortion must be allowed for. Magnesium is no exception to this rule, and this phenomenon was the cause of some of the most persistent and annoying difficulties in the early stages of this development. A considerable number of tests led to making proper allowances in lengths for shrinkage and this difficulty was solved satisfactorily, as far as the dimensional control was concerned, at an early stage of development. Shape distortion due to shrinkage proved much more difficult to control.

In structures of this nature, distortion manifests itself principally as buckling of the monocoque shell, particularly at those places where the curvature is not pronounced. However, there was developed a simple and satisfactory method dealing with the buckling distortion, which does not harm the metal either internally or externally. This method has been used on the shell surfaces of the wings described in this paper, and by its use it is possible to obtain smooth, non-buckled surfaces after welding. By this method heat and pressure are applied to the buckled structure through the use of ironing pads which relieve the internal strain in the sheet.

To make certain that no excessive locked in strains are set up in Heliarc welded structures, experiments were carried out to obtain the absolute value of internal strains in magnesium alloys induced by welding. At the worst, these stresses were found to be of the order of 1000 lbs. per sq. in. max., and are, therefore, of little consequence as far as the impairment of the integrity of Heliarc welded magnesium alloy structures is concerned. This is probably due to the relatively low modulus of elasticity and low yield strength of these alloys; both of these physical properties tend to adjust the metal structure readily to any internally imposed strains from welding.

The amount of welding is not indiscriminate; proportioning of the welded seams to the loads carried through them and selecting the type of weld to best fit the conditions of elastic flexure of the structure should be two recognized principles of electric arc welding application. It has been noticed that on a number of electric arc welded steel structures these principles have not always been observed. The magnesium alloy Heliarc welded wings have been designed with great care in this respect. Full length seams are used only where necessary. Otherwise, the seams are of the interrupted type, either on one side, or of staggered interrupted type on both sides of the edge of a plate or of an extrusion attaching joint.

These practices were made possible by the high metallurgical quality of the seams, their uniformity and relatively high strength. For design purposes the Army Air Force allowed 75.9 per cent of the ultimate tensile strength of the metal to be used as the strength of the Heliarc welded seams in tension. This figure is based on tests of seams made in the early stages of this development, and much higher uniform values are now consistently being attained, as previously noted.

The wing tip and the aileron (Figs. 3 and 5) were made of 0.050 in. thick Dowmetal J-1 annealed alloy. The reason that annealed metal was used for these two structures lies in the fact that loads on them are relatively low. Since 0.[illegible] in. was self-imposed by the authors as the minimum practical sheet thickness of J-1 alloy for this design, it appeared that annealed metal could be used with safety and with the advantage that such material is delivered flatter than the equivalent gage of the cold rolled, strain hardened J1-H sheet.

Furthermore, the wing tips were formed to shape by drop hammering of heated sheet (approximately 600 deg. F.), which would have obliterated most of the cold rolled strength of the J1-H alloy. In point of accomplishment, the wing tips and the ailerons are even more noteworthy than the wings themselves. Both have already been tested for strength and found to be stronger than necessary and also more rigid than expected from past experience with comparable aluminum alloy riveted structures.

The utmost structural simplicity and the small amount of arc welding required to assemble the ailerons and the wing tips distinguishes these units as first class production articles.

The landing flap, Fig. 4, is an open structure, simple and easily accessible for welding. The same few structural elements are used in its assembly as on the wings.

The wings are attached to the airplane center section by riveted aluminum alloy flanges. This joint necessarily was copied from the aluminum alloy wings, because the arc welded wings have to fit, by exchange, a conventional riveted aluminum alloy airplane.

Serviceability of Magnesium

In the past magnesium alloys have suffered from two generally known and popularly misunderstood faults. One is the general fear of their inflammability and the other is a deep-rooted, and by past

performance somewhat justified, conviction that these alloys corrode rapidly.

As to the first, the experience of the authors is that the fire hazard has been greatly exaggerated; in spite of the intensive welding development of these alloys in the shops during the last two years, the only fires involving magnesium were those started deliberately for test purposes, or in experiments before helium was used. It was discovered that the zinc chromate primer, generally used by the aircraft industry, acts as a potent fire inhibitor on magnesium, and that it is in fact impossible to ignite these alloys, even artificially, if they are protected by it. Magnesium retains its elastic modulus to much higher temperature than is the case with aluminum alloys. This is an extremely desirable property, and in practice it means that a zinc chromate protected magnesium alloy structure will not collapse as readily as an aluminum alloy structure might do if exposed to fire.

The weather durability of magnesium aircraft structures in service is still undetermined. However, a wealth of artificial corrosion testing, and also gratifying results of the use of magnesium alloys on several truck bodies through a number of years, furnish convincing proof that corrosion is not as dangerous as is generally believed, provided proper surface protection is given. This protection consists of treating the finished, welded and cleaned structures with sodium dichromate and painting them with standard zinc chromate primer and two coats of finishing lacquer. This protection has been found to be sufficiently elastic under load, as well as abrasion resistant.

One of the least desirable physical characteristics of the magnesium alloys is their inclination to strain corrosion. The elasticity of the surface finish helps here a great deal, but in addition the authors deliberately avoided stress concentrations in their design and saw to it that the maximum principal stresses anywhere in the wing remain low, viz. 12,600 lbs. per sq. in. max. in compression and 19,170 lbs. per sq. in. max. in tension.

Compared to the maximum allowable yield point in tension of 33,000 lbs. per sq. in. for J1-H alloy, this utilization of the material seems wasteful; however, it was done deliberately in order to favor the rigidity of the outer wing shell, and also to diminish tendencies to strain corrosion. It is apparent, however, that as service experience is acquired it may be possible to design these structures for less weight than the equivalent weight of aluminum alloy riveted structures, without abandoning the non-buckling principle.

Static tests of magnesium wings have demonstrated that these wings are elastically more flexible in bending than aluminum alloy wings. This is a desirable feature, as it tends to reduce excessive loads in gusty air, particularly when it is realized that the internal damping of magnesium alloys is several times greater than of aluminum alloys. On the other hand, the magnesium wings are more rigid in torsion than corresponding aluminum alloy riveted wings. This is also a very desirable property to eliminate danger from flutter, and can be traced to greater thickness, and to the absence of slippage in welded seams.

Fig. 3. BC-1 wing tip assembly.

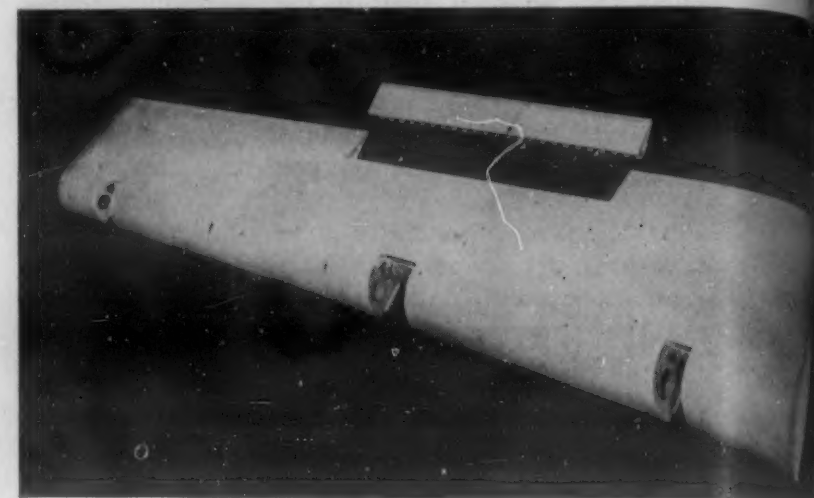


Fig. 5. BC-1 aileron and tab assembly.

Detailed Cost Comparison

Dollar evaluation of the economic advantages of electric arc welding as applied to magnesium aircraft structures is a difficult task because of the many variables and intangibles involved. Direct comparison of the cost of a Heliarc welded seam and a riveted seam in the same materials is given as follows:

Table of Comparison of Joint Cost Per Foot
In 0.10 sheet — Approximate Equal Strength

	Heliarc Welded	
Surface preparation	0.250 hrs. at $0.97 per hr.	0.08
Setup	0.083 hrs. at 0.97 per hr.	$0.24
Weld time	0.100 hrs. at 1.40 per hr.	0.14
Cleanup	0.083 hrs. at 0.97 per hr.	0.08
Helium 1 cu. ft.		0.02
Magnesium filler rod and tungsten electrode		0.01
Electric current		0.01
Total direct cost		$0.58
Overhead on labor at 100%		0.56
Total cost per foot		$1.14
	Riveted	
Layout and drill 24 holes	0.166 hrs. at $0.97 per hr.	$0.16
Countersink 24 holes holes	0.10 hrs. at 0.97 per hr.	0.10
Drive 24 rivets	0.40 hrs. at 0.97 per hr.	0.39
24 rivets		0.04
Total direct cost		$0.69
Overhead on labor at 100%		0.65
Total cost per foot		$1.34

It will be noted that in this comparison the weld is somewhat less expensive than the equivalent riveted joint. Such a comparison, however, is unduly conservative in that the cost of joining the parts is only a minor element in the overall economic gain to be made.

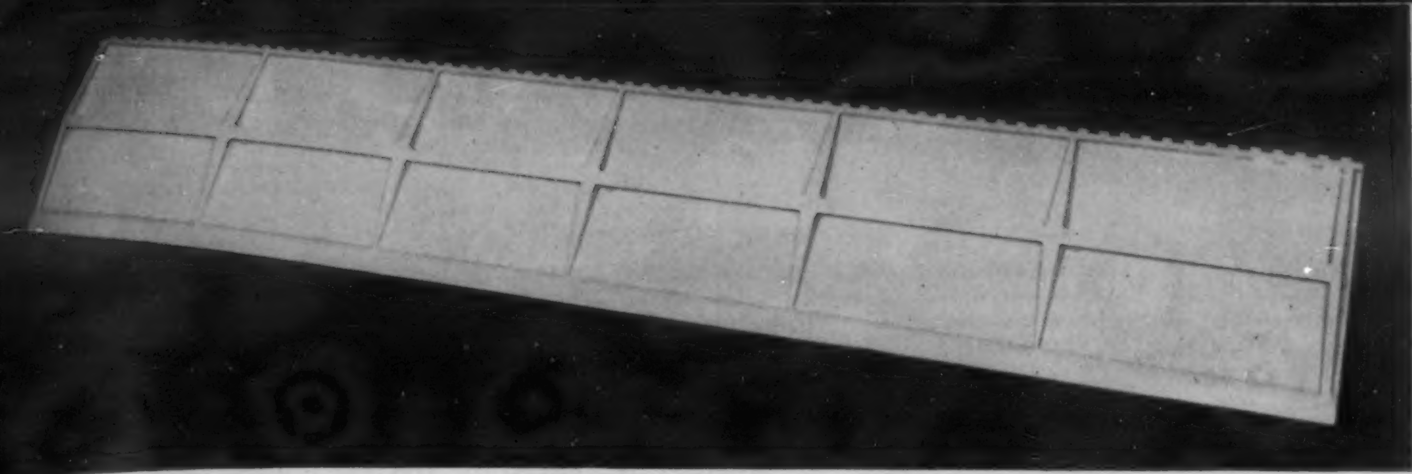


Fig. 4. BC-1 landing flap assembly.

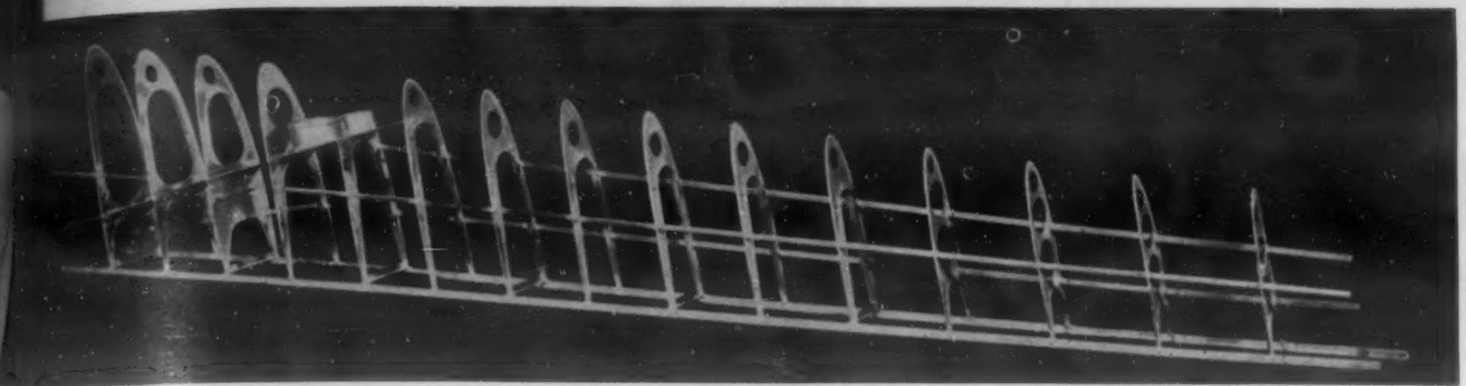


Fig. 6. The complete internal structure assembly of the nose portion of the wing.

If the authors' philosophy is followed (namely that welded magnesium structural design should be directed primarily to simplicity and aerodynamic excellence) it will be found that weights generally equivalent to those of contemporary structures of riveted aluminum alloy will be obtained. There is, therefore, little or no advantage from the standpoint of weight saving. On the other hand, the reduction in number of parts for a given structure, and the possible reduction of drag of the finished airplane are factors of great importance.

The former advantage may be visualized to a limited extent by reference to Fig. 6. This photograph shows the complete internal structure assembly of the nose portion of the wing. All that remains to accomplish is the attachment by welding of the relatively thick cover sheet to the rib structure. A comparative check with a similar conventional structure indicates that the welded design has slightly more than one-half the number of feet of basic attachment of parts to each other employed in cases where riveted aluminum construction was used.

In addition to this fact, the actual number of pieces required in the design is in the order of one-half the number required in the comparable aluminum alloy structure, so that the cost of fabrication may be expected to be reduced in similar measure. Unfortunately, at this writing the welded wings are only being produced in experimental quantities and no cost data on conventional wing structures in comparable quantities are available to the authors.

General Economic Evaluation

The actual structural cost in itself is still of minor importance in the overall economic advantage to be gained, however, because the most valuable contribution of this program lies in the possible reduction in drag of the finished airplane. Within the past few years a whole new family of high performance airfoils has been developed in which profile drag reductions of from 30 to 50 per cent have been obtained. These airfoils must be constructed with a degree of accuracy that is virtually impossible to obtain in conventional riveted structures which develop surface waves within the flight range.

Monocoque welded magnesium structures, however, are readily adaptable to these requirements. They are designed with comparatively thick skins which do not buckle locally within the normal range of flight loads. Their surface finish can be as smooth as that of a fine automobile, and held within accurate limits. The outer surface of all welded joints may be ground flush with the face of the surrounding sheet so that no measurable inequality occurs at seams or joints. Butt joints and seams in the surface covering are a normal design procedure, so that laps as well as rivet irregularities and local buckling may be completely eliminated.

Depending somewhat on cover thickness and internal structure, some slight surface irregularities may exist, but these at the worst can be limited to long waves of very low magnitude which do not adversely affect the drag of the structure. In summarizing this point it may be said that a parasite drag reduction of at least 30 per cent may be obtained through the use of the new low drag airfoils which, to the best of the authors' knowledge, can only be built to proper accuracy and finish in Heliarc welded magnesium, if metal is to be used.

These figures are all based on a 900-mile trip. After the war is over, transports flying across the nation in eight to ten hours, and with only one stop, will soon go into service. On such longer hauls the figures become even more impressive because the longer trips require a higher percentage of useful load to be devoted to fuel, and this increases the percentage of saving per ton mile through reduction drag, out of all proportion to the increase in trip length.

(Editorials continued from page 281)

desire for adding to the total of accurate metallurgical knowledge.

To be completely logical, METALS AND ALLOYS should advocate extinguishing itself, so as to "eliminate duplication and conflict" with other metal magazines.

As a member of the A.I.M.E. and A.S.M., I hope both will continue to "compete." Hell, can't folks *compete* without *fighting?*

H. W. GILLETT

May 27, 1943

Chief Technical Advisor
Battelle Memorial Institute

A Few Others

Typical of the approving comments that we have received is the following:

I was rather interested in your editorial in "Metals and Alloys" in reference to the A.S.M. vs. A.I.M.E. The Chicago section of A.I.M.E., of which I am a member of the executive committee, has been seriously considering what steps the A.I.M.E. could take to be of more direct value to its membership. At present, there is a large overlapping of these two societies.

It might be of interest to point out to you that even the A.S.M. has had some cases of groups falling away from the society and forming a special heat-treating group. Some of the fellows felt that they were not getting all they could from the local meetings because they were not entirely in their particular field of work.

Here is another:

Just a word regarding your editorial in the May issue of METALS AND ALLOYS. I have heard considerable comment about this question, and if it accomplishes the needed stirring up of opinion, as it now appears, it is well worth while and timely. As you know, there has been a slight overlapping for some time between the two societies and personally I feel that it is time we have a line of demarcation. If one society wishes to abandon a part of their activities and not keep up a pretense of doing certain things, now is a good time to bring this about. I think perhaps your editorial may help to effect this change in policy.

These men hold office of some kind in either A.I.M.E. or A.S.M. and have asked therefore that their names be withheld.

Our Reply

When we suggested in our editorial that the A.I.M.E. relinquish the physical metallurgy field to the A.S.M., we were thinking of something quite different from Professor Mathewson's interpretation and were evidently not sufficiently lucid in our explanation. It was not our intention to suggest the elimination of the Institute of Metals Division of A.I.M.E. but rather that it confine its activities to the metallurgy of non-ferrous metal production and refining.

In addition to the process technology of metal-production this would necessarily include alloying, constitutional metallography and any other branch of physical metallurgy with which men in the copper and brass, aluminum, nickel and other non-ferrous metal-producing industries are normally concerned. It should *not* include the metallurgy of heat treatment, welding and finishing of non-ferrous metals as generally performed in the metal-working and metal-consuming industries. These last we would reserve for the A.S.M.

By and large the membership of I.M.D. would, if taken exclusively from the non-ferrous metal-producing field, be little different from its present composition. Similarly the Division could emphasize the *science* as against the *art* without conflicting with our basic suggestion that it stick to those activities that interest engineers and metallurgists in the non-ferrous metal-*producing* industries.

The Iron and Steel Division is virtually doing that already in the ferrous field and without sacrifice of professional or scientific standards. We'd like I.M.D. to be to the non-ferrous metal-producing industries what the Iron and Steel Division is today to the iron and steel making industries.

And then if the A.S.M. could confine its services and activities and roughly its membership to the industries that use and fabricate metals, the pattern would be complete and there would be a minimum of duplication. Admittedly each society would have to surrender something, but that is the obvious price that must be paid for the elimination of conflict.

Dr. Gillett's point is that the competition is not necessarily undesirable and therefore the price just mentioned is too high. Although we may be wrong, we do feel that business enterprises (including commercially-published technical magazines) should compete, but that technical societies should not. No situation similar to that involving our two metal societies exists among the other technical societies. Such competition, to us, represents waste motion and a confusion and misdirection of professional effort.

Starting from scratch, no intelligent person or group would have simultaneously established two societies operating along the lines currently followed by the Metals Divisions and the A.S.M. Are the A.S.M. inadequacies that Dr. Gillett alleges a valid reason for opposing a correction of the present situation? On the contrary, we believe that these defects should be remedied if and where they exist, and indeed that the A.S.M. is just about ready for some kind of professionalization of its membership set-up. There is no reason, under the arrangement we suggest, why the technical standards of A.S.M. cannot be made every bit as high as A.I.M.E.'s.

The answer to Dr. Gillett's last question (about fighting) is "in this case, no!" And it's that kind of fighting we should hate to see develop between the metal societies. —F. P. P.

Guns and Ammunition

With many plants converted from their peacetime products to the manufacture of gun parts or ammunition, a brief outline of the nomenclature of these weapons is timely. Since the term "gun" includes any tube built to withstand a given internal pressure, and to discharge a projectile at high velocity, it applies to a pocket pistol; a 16 inch monster mounted upon tons of concrete for coast defense, or aboard a battleship; an automatic arm specially lightened for aircraft use; anti-aircraft ordnance designed for rapid high-angle fire; or field pieces moving on railway cars or tractors. Definitions to cover such a variety must necessarily be general and subject to qualifications.

Guns

Guns are sized by the diameter of the inside surface of the tube, or *bore*. This diameter is called the *caliber*. The length of the gun is usually expressed as a multiple of this bore diameter, so that a 14 inch, 45 caliber piece is one of 14 inches bore diameter, and 14 x 45 in. or 52 ft. 6 in. long from breech face to muzzle. This system of sizing instantly gives the ordnance engineer a picture of the ratio of barrel length to bore diameter.

To impart a rotating motion to the projectile, and so keep it in position and upon its trajectory during flight, all modern guns are *rifled*, that is, spiraling grooves are cut into the bore from powder chamber to muzzle. The smooth bore gun disappeared from the standard armament field shortly after the Civil War, except for small trench mortars and similar pieces, so that today the 14-in. piece of naval ordnance as well as the infantry's standard shoulder arm are *rifles*.

The rifling itself may be of several forms, of varying number and relative sizes of *grooves* and *lands*, and of differing degree of inclination, called *twist*. The twist may be *uniform* throughout the length of the bore, or may increase in degree toward the muzzle (*increasing twist*), or may be uniform for part of the bore and increasing for the remainder. The point at the forward end of the powder chamber where the grooves first cut into the bore is called the *origin of rifling*.

Wall ratio is the ratio of the outside and inside diameters of the barrel at a given point.

Types of Construction

Monobloc—one-piece construction, machined from forged or centrifugally cast blanks. Used for all small arms, and for most cannon up to about 8 in. Larger of these sizes are usually radially expanded—subjected to such internal hydraulic pressure as will permanently deform the diameter and place the inner surfaces under initial compression.

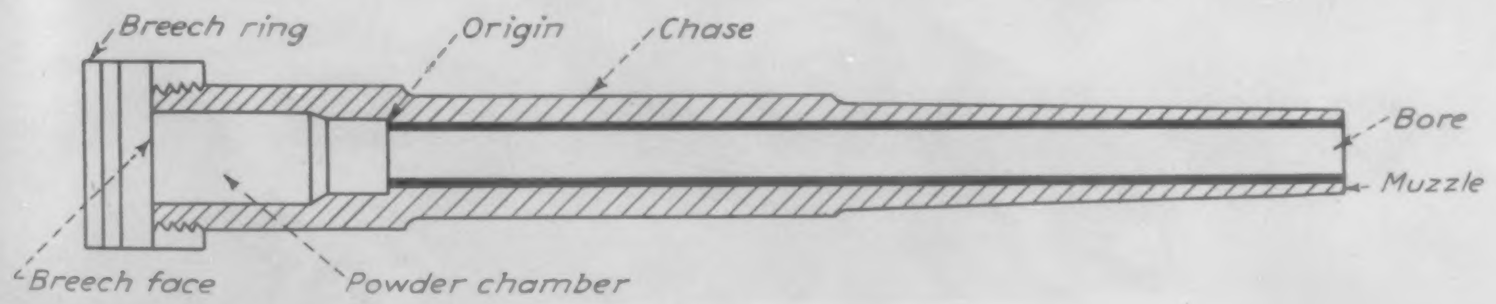
Built-up—from two to seven or more concentric cylinders assembled by shrinkage to form the barrel. Initial internal compression is obtained by this shrink assembly. Smaller calibers will usually consist of a tube with shrunk-on jacket, while larger guns usually have about five principal sections, and may have 15 or more hoops. The standard method of construction for guns above 8 in. in diameter. Permits replacing of a worn tube and salvaging of a gun which would otherwise be scrapped.

Wire-wound—compression is applied to the tube by winding it with wire under tension. No guns of this type are now being made in this country, although some of earlier manufacture are still in use.

The *breech ring*, screwed onto the barrel, provides for the attachment of the breech mechanism. This becomes quite complicated in the *semi-automatic* arms, in which part of the energy in the powder charge is used to perform some of the functions of ejecting the fired case, reloading the gun, or firing the next round, or in the *fully automatic* weapons, in which all of these operations are performed mechanically from powder energy.

The *breech block*, which closes the rear end of the barrel during the firing of the gun, becomes a threaded plug for the larger pieces, and a sliding wedge for the smaller arms. A *breech housing* contains the breech block and its operating mechanism in the hand arms, machine guns, and automatic cannon. The barrel is usually supported in a *cradle* in the larger pieces. Recoil and counter-recoil are provided for by springs or hydraulic cylinders.

The gun *mount* will of course change almost out of recognition in adapting itself to the wide variety of conditions under which guns must perform. Several elements will be present in nearly every mount in some form or other, however. The barrel, with its breech assembly, cradle, recoil mechanism, etc., constitute the *tipping parts*. *Trunnions* on either the barrel or the cradle rest in trunnion bearings on the *carriage*, or *pivot yoke*, and permit the barrel to move in elevation. *Sights* are usually attached to the carriage.



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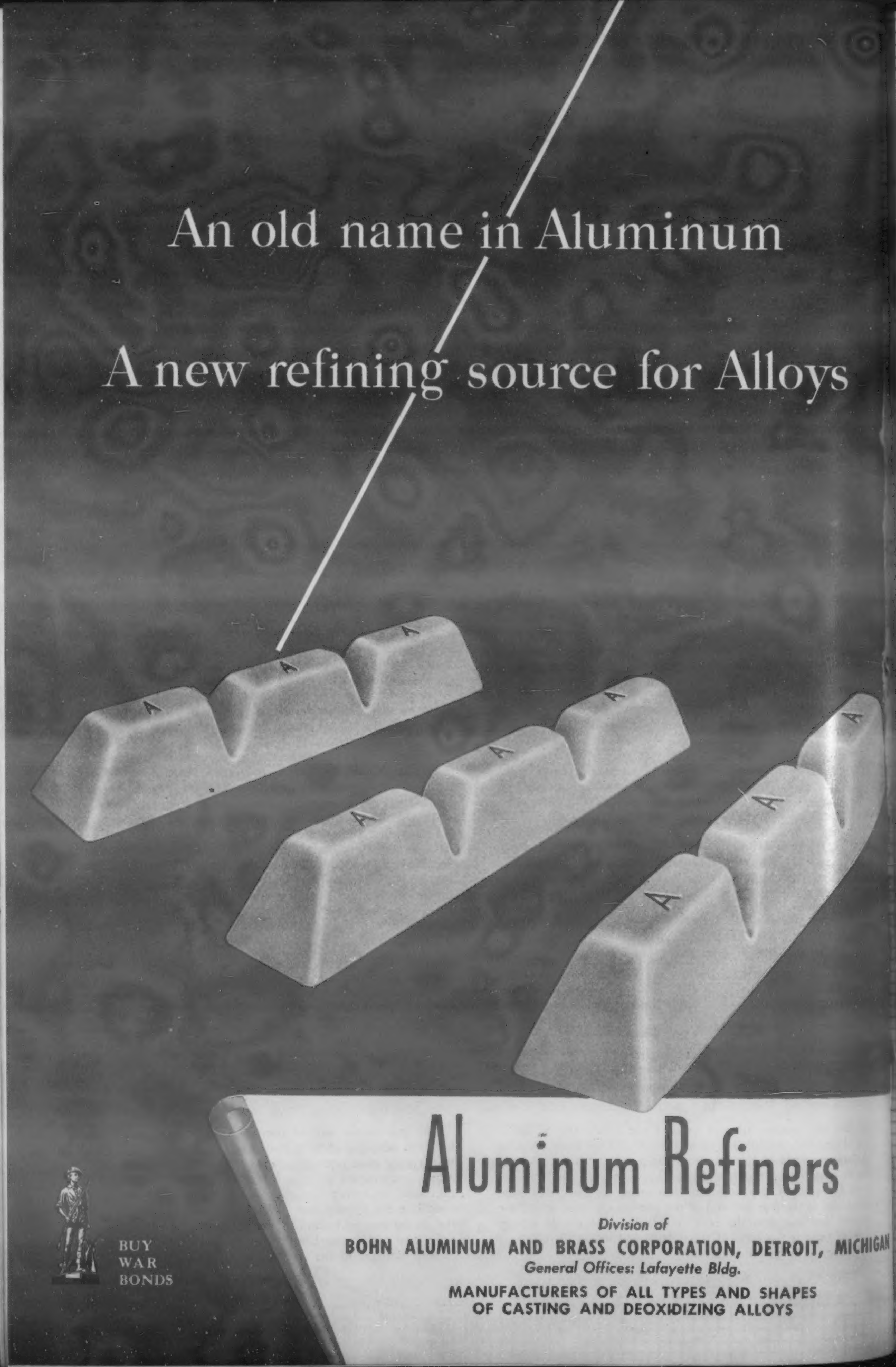

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NUMBER 19 (Continued) GUNS AND AMMUNITION

The *base,* or *racer,* supports the carriage and moves with the barrel in train or traverse. Guns intended for mobile field service are frequently non-traversing, or traverse only a few degrees, the mount shifting to provide wider sighting. Flexible aircraft armament mounted in a turret or tourelle can often be traversed only by motion of the entire turret. This applies also to naval ordnance mounted in turrets. For such mounts the base rests on rollers on the *stand,* which is securely fastened to the deck of the ship, etc. Field artillery is held in position during firing by a *trail,* with a *spade* and a *float* to provide support in the soil.

The standard small arms include *pistols, shoulder rifles, automatic rifles, submachine guns,* etc. *Machine guns* are usually tripod- or mobile-mounted, and require a crew of two to four men. *Automatic cannon,* in the 20- to 40-mm. calibers, are frequently used for anti-aircraft fire. Special designs of the machine guns and smaller automatic cannon are mounted in aircraft. Of the heavier pieces for service on land, coast defense artillery includes large-caliber guns in elaborate permanent emplacements and railway artillery as well as small arms and anti-aircraft weapons. Railway mounted guns are also used in the field where facilities are available. Field artillery varies widely in its types, with smaller and medium calibers on motorized or motor-drawn mounts now in favor.

While the terms no longer apply sharply, a *howitzer* is usually a field piece designed to fire at high elevation, and a *mortar* is a shorter weapon designed for still higher-angle fire. The purpose of the elevation in both cases is to give plunging fire upon the target.

Ammunition

Probably no ordnance item has its components so misnamed in conversation by the general public as ammunition. Ammunition, while it too must vary with change of size from the .30 caliber rifle to the 16 in. cannon, has several elements always present, even though much changed in form. The combination of projectile, powder charge and primer is a *round.* A *projectile,* solid in small arms ammunition and containing a bursting charge in the high explosive types, is the part fired from the gun, while the propelling charge may be enclosed in a brass or steel *cartridge case,* or placed in the gun in *cartridge bags.*

Upon this basis ammunition is classified as *fixed ammunition,* in which the projectile is crimped to the cartridge case, and the complete round loaded into the gun breech; *semi-fixed* ammunition, with the projectile loosely attached to the cartridge case; and *bag ammunition,* in which bags of pure silk or treated cotton cloth containing the propelling charge are placed in the gun behind the projectile, and the primer inserted in the breech plug afterwards. The first type is used for guns up to about 4 in., the second for those of 4 to 6 in. caliber; and the last for those above 6 in.

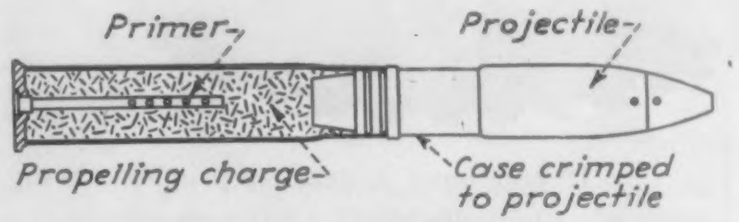
Small arms projectiles may be called *bullets,* although this term is sometimely improperly applied to the complete round. Larger caliber projectiles, holding a bursting charge, may be termed *shells.* These latter may be of several types, designed for specific uses, such as *high explosive* or *armor piercing,* or the projectile may contain many small spherical shot *(shrapnel). Shot* is a term also applied to armor-piercing or semi-armor piercing projectiles that are solid steel.

The projectile, if of explosive type, will contain a *contact* or a *time fuze,* or a combination of both. For armor-piercing projectiles a *delay fuze* is required to detonate the projectile inside the armor. In aircraft ordnance a *supersensitive fuze,* to fire immediately upon contact with a very light object, is used.

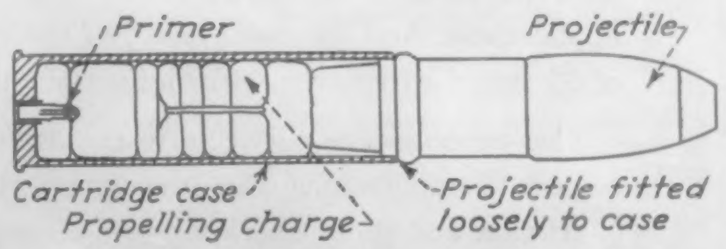
The fuze fires a *detonator,* or small charge of sensitive explosive, which in turn fires a *booster charge.* This latter is an explosive intermediate in sensitivity between the detonator and the *bursting charge,* the high explosive load in the projectile.

The *rotating band* on the projectile is usually made of copper, gilding metal, or copper-nickel, and provides a seal for the gases of the propelling charge while forcing the rotation of the projectile as it moves through the gun barrel.

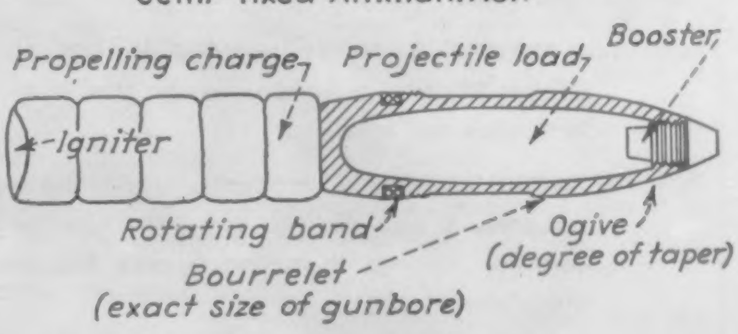
A *tracer cavity* in the base of the projectile may be filled with the magnesium-base combustible used with this type of projectile.



Fixed Ammunition



Semi-fixed Ammunition



Bag Ammunition

The propelling charge, whether in a cartridge case or in bags, must be fired by a *primer,* or *detonator,* or *initiator.* This is a sensitive explosive first fired by the gun's firing mechanism, whether a striker pin or electricity. In order to transmit the flame quickly to the charge an *igniter* is usually inserted between the primer and the principal charge in medium and large caliber ammunition.

Compiled by Kenneth Rose, Engineering Editor

If you have a gearing problem, bring it to Westinghouse. Skilled Micarta engineers will be glad to study your product and analyze its applications. And they will give you the benefit of 35 years' experience with industrial plastics.

This experience is particularly extensive with respect to applications where resilience, absence of friction and quiet operation are of supreme importance . . .

FOR EXAMPLE, IN TEXTILE SPINNING FRAMES, thousands of tiny Micarta gears give service that is essentially frictionless and noiseless.

IN CARGO WINCHES, Micarta gears provide quieter operation than is possible with any other type of gearing material. Absence of friction reduces fire hazard by eliminating sparks.

AND IN MANY OTHER INDUSTRIES . . . hundreds of thousands of other Micarta gears are in use where dependability is vital.

In these applications, Micarta has replaced metals and other critical materials and is serving better. In every case, Micarta absorbs vibrations and cushions repeated shocks without deterioration.

When your present manufacturing operations call for nonmetallic gears, or where gears are involved in your postwar plans, be sure you have all the facts about Micarta. Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pennsylvania.

J-06337

TYPICAL MICARTA TOUGH JOBS IN WAR APPLICATIONS

- Aircraft structural parts
- Industrial gears
- Instrument panels
- Steel mill bearings
- Thrust washers
- Marine bearings
- Protective helmet liners
- Aircraft control pulleys
- Bus supports
- Fuse mountings
- Insulating washers

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METALS and ALLOYS

Engineering File Facts

NUMBER 20

Tool-Tipping by Brazing

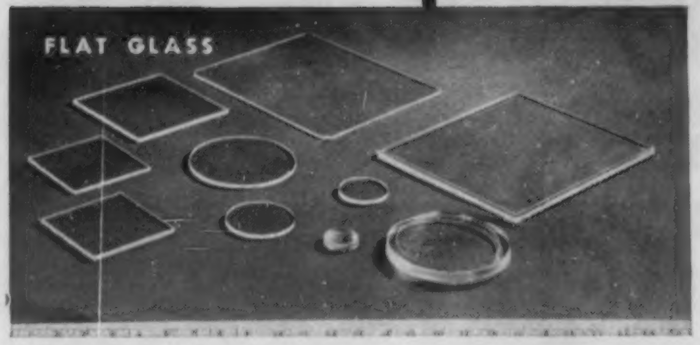
PROCESSES AND PROCEDURES
Brazing

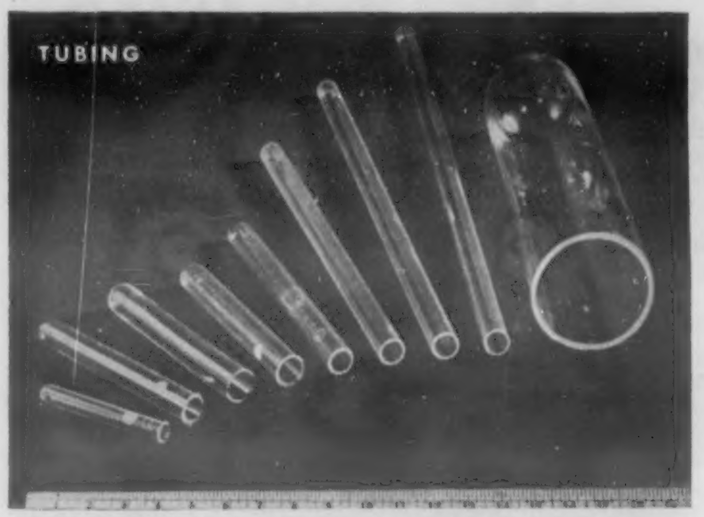
Method	Low-temperature Methods	High-temperature Methods	
Application	This process is especially adapted to the requirements of high speed steel.	This method is used for tipping with annealed high speed steel.	
Apparatus	An oxyacetylene welding torch. A vise or jig in which to hold the tool in a convenient position.	A high heat furnace of the type used for hardening solid high speed tools, or for brazing tungsten carbide bits; it is advantageous to have the furnace of a type in which the heat can be localized on the end of the tool. A preheating furnace is useful, but if not available, the required preheat may be applied in the cooler portions of the high heat furnaces.	
	For Brazing with Silver Alloy	**For Brazing with Copper**	**For Brazing with Iron-alloy Cement**
Materials	A silver brazing alloy shim of proper thickness, usually .003 in. to .008 in. with a melting point of 1175 deg. F. maximum. A flux that will dissolve oxides found on high speed steel, and which will be fluid and active at brazing temperature. A good grease solvent.	Copper shims .003/.005 inches in thickness. Brazing flux suitable for brazing with copper. A good grease solvent.	Iron-alloy cement, copper sulphate, sulphuric acid.
Procedure	For hardened high speed steels: 1. In joining an inserted tip to a shank, machine or grind a recess in the shank to match the tip. 2. Make sure that the surfaces of both recess and tip to be brazed are fairly smooth. A milled surface or equivalent is satisfactory. 3. Clean all surfaces to be brazed with a good grease solvent. 4. Place the shank in the vise or jig with the recessed end projecting. 5. Coat the recess and the tip with flux. 6. Place the shim of silver brazing alloy on the entire recessed surface to be brazed. 7. Place the tip of the shim. 8. Apply heat with the oxyacetylene torch. The flame should be neutral or slightly reducing. 9. Direct the flame to the underside of the shank below the recess, moving the flame back and forth to distribute the heat evenly. Heat the shank until it becomes a barely visible dull red. 10. Withdraw the flame to a greater distance from the work and continue heating until the brazing alloy melts, keeping the temperature as low as possible in order to avoid drawing the temper from the tip. 11. Make sure the alignment of the tip is correct. 12. Press the tip firmly into place. Maintain the pressure until the brazing alloy has solidified. 13. When the brazing alloy has solidified, as determined by eye, immerse the tool in oil long enough to set the braze, then cool in air. The hardness along the cutting edge should be comparable with that of solid hardened high speed tools.	1. Machine or grind a recess in the shank to match the tip. Make sure that the surface of the tip to be brazed is fairly smooth. A milled or ground surface is satisfactory. 2. Remove all grease and dirt with the solvent. 3. Coat the tip and the recessed end of the shank with copper type brazing flux. 4. Place the shank in the furnace, and heat until the flux flows freely. Maintain a neutral or slightly reducing atmosphere. 5. Remove shank and fit the copper shim into the recess. 6. Fit the tip onto the shim. 7. Preheat the assembled tool to about 1600 deg. F. in the preheating furnace or in the cooler portion of the high heat furnace. 8. Transfer the tool to the high temperature furnace and hold it at the proper quenching temperature for the grade of high speed (2200-2350 deg.), until the tip has soaked out. Soaking time should be kept to a minimum to prevent grain growth. 9. Since the melting point of copper is 1980 deg. F., the copper shim will have melted and spread over the interfaces. Withdraw the tool. 10. Adjust the alignment. 11. Press the tip firmly into place to squeeze out the excess copper and flux. 12. As soon as the copper has solidified, quench the tipped end in oil until the temperature has dropped to below 200 deg. F. 13. Temper the tool at 1000-1050 deg. F.	1. Prepare a flat surfaced recess for the tip. The surfaces to be joined should be fairly smooth. Milled finish or equivalent is satisfactory. 2. Clean surfaces with grease solvent. 3. Prepare a solution of 3 ounces of copper sulphate and 10 drops of concentrated sulphuric acid, dissolved in one pint of water. With this solution paint the surfaces to be joined. 4. While the surfaces of the recess are still moist sprinkle over them a layer of commercial alloy cement. Smooth out the layer so that it is flat and about 1/32 of an inch thick. 5. Press the tip firmly into the recess. 6. Set the tool aside for an hour or more. This will affix the tip securely enough to permit handling. 7. Preheat the tool to about 1600 deg. F., in the preheating furnace or in the cooler portion of the high heat furnace. 8. Transfer the tool to the high temperature furnace and raise it to the quenching temperature proper for the grade of high speed involved (2200-2350 deg. F.). 9. Soak out the tip, but keep the soaking time to a minimum. 10. Withdraw the tool and press the tip into the recess to squeeze out excess cement, using foot treadle, or tongs. 11. Check the alignment. 12. When the cement has solidified, quench the tool in oil or air until the temperature has dropped to below 200 deg. F. 13. Temper the tool at 1000-1050 deg. F.

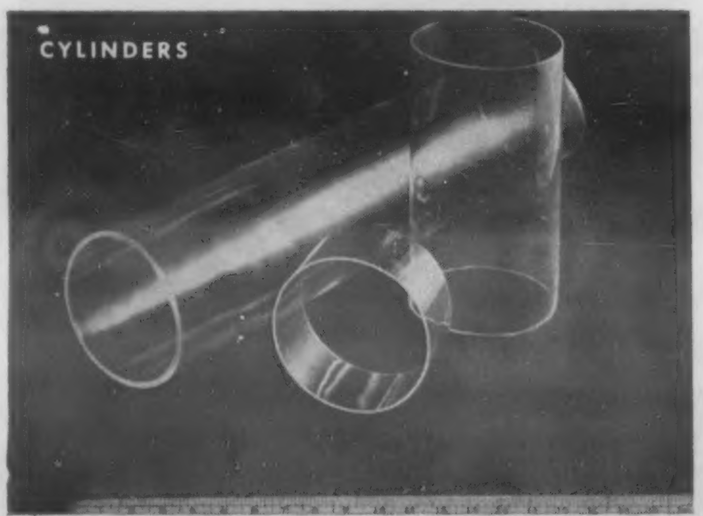
Prepared by Tools Division and Conservation Division, War Production Board, Washington

FOR HIGH TEMPERATURES,

YOU WANT CORNING'S NEW "*VYCOR*" brand GLASSWARE







You can use "VYCOR" brand Glassware at *continuous* operating temperatures up to 900° C. It will stand considerably higher temperatures—up to 1200° C.—for shorter periods in some instances. And—especially important—"VYCOR" brand Glassware tolerates enormous thermal shocks. Heated to cherry red, it can be plunged into ice water without breaking.

"VYCOR" brand Glassware is made from 96% Silica Glass No. 790. Its chemical stability *is superior to that of any other commercially available glass composition.* Highly resistant to corrosive chemical solutions (except HF), it is extremely hard, and has unusual abrasion resistance. Its quartz-like composition provides a new tool to combat some of the toughest service conditions in plant and laboratory.

For absolutely new standards of performance, this Glass No. 790 may be exactly what you have been looking for. Below is given a list of the typical glassware items now available. Write us for complete details. Industrial Division, Corning Glass Works, Corning, New York.

PHYSICAL PROPERTIES

Softening point, approx.	1500° C.
Linear Coefficient of Expansion per ° C.	0.0000008
Specific Gravity	2.18
Refractive Index	1.458
Tensile Strength	Comparable to Pyrex Chemical Glass No. 774
Loss in Weight on Heating and Cooling	Negligible
Visible Light Transmission for 2 mm. thickness	92%
Ultra Violet Transmission at 254 millimicron line for 2 mm. thickness	2 to 4%
Temperature limit in long time service	900° C.

RECENT AND SUGGESTED USES

High temperature gas sampling tubes.

Thermocouple sheaths.

Radiant heating element sheaths.

Sight Glasses for high temperature furnaces and chemical processing equipment.

Pilot plant and small plant-scale fusion and sintering operations.

Reaction-vessel tubes for high temperature control instruments.

Low expansion reference rods in temperature control.

Mechanical seal-rings for pumps and other rotating machinery.

TYPICAL GLASSWARE ITEMS NOW AVAILABLE

CONTAINERS: *Trays*, 10¼" to 15½" x 1[illegible]". Flasks, up to 7 litre capacity. *Beakers and Jars*, up to 2500 ml capacity.

TUBING: Maximum O.D., 31 mm; maximum length, 5 feet; maximum wall thickness, ¼ inch.

CANE OR ROD: Maximum O.D., $\frac{7}{16}$ inch; maximum length, 40 inches.

FLAT GLASS: *Rectangular Panels*, 8" x 10" x ¼". *Roundels*, 5⅛" dia. x $\frac{3}{16}$" thick. *Sheet Glass*, up to 15½" x 15½" x ⅛" (made from flattened cylinders). *Standard Squares*, 5⅝" x 5⅝" x 7 mm thick (also 3, 4 and 6 mm thick).

CYLINDERS: Up to 4½" O. D. x 30" long. Longer lengths may be obtained by sealing pieces together. Maximum wall thickness, ¼ inch.

"VYCOR" is a registered trade-mark and indicates manufacture by Corning Glass Works.

CORNING
Glass Works
Corning, New York

Vycor Industrial Glassware
BRAND

NUMBER 21

PROCESSES AND PROCEDURES
Forging

Forging Operations and Equipment

Forging, the working of metal heated to a plastic stage, is one of the oldest metal arts. If we include cold working, as we must in certain present present-day operations, it is the oldest. Since the modern forge shop invariably includes several machines primarily intended for operating upon cold metal, and since even operations like drop forging may require a cold restriking step, it is impossible to limit forging operations to hot work exclusively. This outline classifies the processes and machines in general use in the modern forge shop, and gives typical applications.

Operation	Description	Machine	Uses
Heavy forging	Working down of ingots or large billets.	Hydraulic press, steam press, power hammers	Preparation of shop size billets. for subsequent working
Drop forging	Metal formed by impact of falling hammer. Both hammer and anvil usually fitted with special dies. Forming may take place in succeeding steps, with several recesses cut in the same dies.	Drop hammer, board hammer, steam drop hammer	Wide variety of small items, such as wrenches, having both profile and surface forming.
Upsetting	Building-up of metal at some point by shortening the piece through axial compression.	Bolt heading machine, upsetting machine, nail machine, resistance butt welder	Heading operations in general — bolts, nails, etc.
Forming	Pressing of metal into shape, usually with the aid of forms or dies.	Forging rolls, steam press, forge press, hydraulic press, bulldozer, coining press, sizing press	For shaping large pieces, as boiler heads; bar stock
Drawing-out	Lengthening of stock under impact or pressure.	Trip hammer, helve hammer, steam hammer, air hammer, forging rolls, forging presses	Working down large billets, bar stock, etc.
Trimming	Cutting away excess metal, as flashing from drop forgings.	Sizing press, power hammer, (flash from drop forgings is usually trimmed in last step)	A semi-finishing operation
Edging	Forming the ends of bar stock or similar stock, usually with the aid of dies.	Trip hammer, helve hammer	A shaping operation for bar stock
Fullering	Forming bar stock or similar stock between the ends.	Trip hammer, helve hammer	A shaping operation for bar stock
Swaging	Marking or shaping surface of stock by working between dies.	Trip hammer, helve hammer, rotary swaging machine	Surface working operation
Embossing	Forcing into relief of a part of a metal surface.	Forging presses, power presses	Surface working operation
Coining	Forming, to close tolerances, of a part of a metal surface by applying pressure over a small area.	Coining press, sizing press	Often a finishing operation upon drop forgings or other processes; frequently done cold
Straightening	Aligning of semi-finished parts distorted by processing.	Power presses, forging presses	A semi-finishing operation in making straight or flat work
Ironing	Imparting a high finish to work by squeezing between smooth dies.	Power press	Usually a cold or low heat finishing operation
Planishing	Smoothing and truing work by repeated blows or squeezings between smooth dies.	Trip hammer, helve hammer, power presses	A finishing operation, performed cold or at low heat
Shearing	Parting of metal, usually cold, between sharpened blades.	Vertical shears, alligator shears	Preparation of stock for forging, cutting up scrap, etc.
Hot cutting	Cutting off of excess stock with the hot chisel or slice bar.	Done under a power hammer or forging press	Trimming of billets or stock in process
Forge welding	Uniting of two or more pieces of metal by heating to incipient fusion and forcing together; a flux is applied to eliminate oxide film.	Power hammer or forging press	The smith shop's joining process
Punching	Piercing of thin stock by a shaped tool, held in the machine or forced through by a power hammer.	Punch press, power hammer	Usually a cold operation upon small work
Piercing	Hollowing out large stock by driving a mandrel or pointed arbor into it or through it.	Mandrel and power hammer; piercing rolls	Making of seamless tubing. First step in forging rings.
Extruding	Metal forced through die which forms it continuously in cross-section.	Extrusion press	Making of beams, intricately shaped strips, etc.

Compiled by Kenneth Rose, Engineering Editor

METALLURGICAL ENGINEERING
shop notes

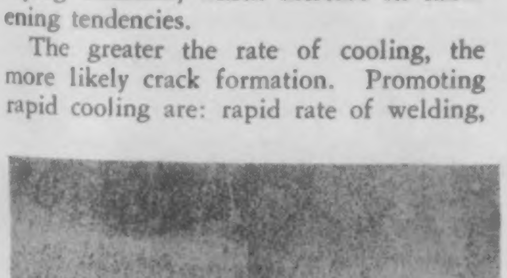
Preheating Steel Before Welding

by A. G. Voetter,
Tempil Corporation

A common misconception among welding fabricators is that plain carbon steels can be welded satisfactorily under any and all conditions without preheat. But welding engineers and metallurgists have learned from experience that this is not true, and that pre-heating is an all-important insurance factor if cracks are to be avoided.

Plain carbon steels of welding quality contain up to 0.35 per cent carbon. The higher the carbon, the harder the steel becomes in the weld and in the heat-affected zone after welding, all of which lessens the ability to deform, thus increasing the danger of cracking. Manganese is roughly one-seventh as potent as carbon in influencing hardness. Often plain carbon steel contains accidental alloying elements, which increase its hardening tendencies.

The greater the rate of cooling, the more likely crack formation. Promoting rapid cooling are: rapid rate of welding,



small electrode diameter, small welding area in relatively large mass of adjacent metal, and low atmospheric temperature. Preheating is at all times highly desirable, and in cold weather is a must.

In the accompanying photomicrographs are welded sections of plain carbon steel (0.20 carbon; 0.65 per cent manganese). The sections were $1\frac{1}{2}$ in. thick, and $\frac{1}{4}$-in. electrodes were used. At the left, where there was no preheating, microcracks developed. At the right, where a gas torch brought the parent metal to 200 deg. F., a homogeneous structure was obtained.

The pre-heat temperature was controlled by a Tempilstik. With this a crayon mark was made on the plate. When the surface temperature reached 200 deg., the mark melted to a liquid smear. Heating was then discontinued and welding was begun. When the smear again solidified, more heat was applied.

Atomic-Hydrogen Repairs Aluminum Castings

by H. A. Beaudoin,
General Electric Co.

The adoption of atomic-hydrogen arc welding to repair imperfect aluminum castings at the plant of a prominent Ohio castings manufacturer has resulted in rejections of under 1 per cent and saving of the company's investment in equipment in less than three months.

Prior to being repair welded, the castings are preheated in a furnace that adjoins the welding booth. Metal of the same analysis as the base metal in the castings is then deposited by a welding operator, who has passed special Air Corps qualification tests. After the completed welds are ground flush with the casting surface, it is impossible to detect the weld outline even by X-ray inspection and physical testing.

The process was developed by the General Electric Co. Experience shows that imperfect castings can be salvaged with absolutely no sacrifice of quality, regardless of the size of the original imperfection.

The clatter of machines and the crackle of welding flames need not hamper a welding teacher. In an airplane plant on the Pacific Coast, teachers use throat microphones, as do members of bomber crews in flight. The welding pupils are equipped with earphones under their welding helmets. Instructions are transmitted easily and clearly without cessation of operations.

—L. Miriam Lucas, U. S. Department of Commerce, San Francisco.

Die Distortion and Cracking

by A. L. Olson,
Lindberg Engineering Co.

What was described as a "heat treater's headache" was brought into the shop for hardening and tempering. It was a die of 1.00 carbon, water hardening tool steel in the form of a circular ring for all but 60 deg., where it bulged off into a shallow box outline. The 16 holes in the ring and box, plus the four corners of the box, presented cracking hazards while its odd shape hinted at distortion.

Each of the 16 holes was plugged tightly with asbestos to equalize the sections and reduce the drastic action of the quench on the thin sections. The die was packed in carburizing compound in a pot 12 in. in diam., 3 ft. deep. The pot was put into an open-fire furnace on a rack to support it above the hearth, then preheated to 1200 deg. F. and soaked there for 1 hr. Then it was raised to 1550 deg., held and soaked for 1½ hrs.

The die was removed from the pot at the hardening temperature and laid flat on the tray of an air-operated quench tank and submerged in oil. (The use of oil for quenching water-hardening steel is practical only when the maximum hardness of the steel is not demanded.) When cooled down to 400 deg., it was removed, laid flat between two fireplates and squeezed in a screw press, remaining until cooled to room temperature. The Rockwell reading was 58 to 60 on the C scale; it was perfectly flat, but had shrunk uniformly 0.003 in.

The die was given a 300 deg. F. temper for 2 hrs. in a forced convection tempering furnace, the Rockwell reading being unchanged.

A lesson to be learned is that in this case a high-carbon, high-chrome air hardening steel, hot quenched; or an oil hardening steel tool, hot quenched; or a manganese oil hardening tool steel, not quenched, would have eliminated many

unnecessary steps and contributed to a more uniform and higher hardness, thereby allowing a higher tempering temperature. Higher tempering temperatures can serve as a valuable means of bringing parts back to their original shape after distortion from hardening.

"Heat Treating Hints"

One usually thinks of hard facing at a working edge. Thus, with an ordinary shovel the edge that first enters the pile would seem to be the logical spot for resurfacing. Yet the maximum bulge on the bottom (each face of the heel) is a practical place to reinforce because of constant scraping against cement floors, etc. The life of the scoop shovel can be increased 4 to 6 times by hard-facing with Haynes stellite rod. Two bands on each face (4 in total) are deposited, each 4 or 5 in. long, ⅛ in. thick and 1 in. apart. It takes 10 min. to do and requires 12 in. of ¼-in. rod.

—"Oxy-Acetylene Tips,"
Linde Air Products Co.

Wooden-Wheeled Trailer for Castings

by R. S. Warren,
Cooper-Bessemer Corp.

Foundry workmen at the Cooper-Bessemer Corp., Mt. Vernon, Ohio, were cramped for space to store huge Meehanite metal engine castings. To relieve this condition, they at first placed some of the flasks and castings on old flat cars and moved onto rail sidings for the necessary period of gradual cooling. But even these facilities were not ample.

Thereupon they constructed low plat-

forms from scrapped steel, discarded parts, and added two heavy wooden wheels to permit portability. Now, castings weighing up to 16 tons are placed on these improvised trailers, coupled to the shop's electric-powered utility trucks, and taken to yards outside the plant for cooling and temporary storage.

The same method is also used to save time in transporting castings to and from the chipping and painting department.

A Niles, Ohio, company increased its welding speed from 7 in. per min. to 16 in. electrodes. The Downington Iron Works, Downington, Pa., reduced their time on a particular job from 4½ hrs. to 3½ hrs. by a change from a 5/32 in. electrode to a 3/16 in. electrode. Similar increases in welding production have been accomplished by attention to closer fit-up and special positioning fixtures, which allow the larger electrodes to be used.

—J. R. Morrill,
Lincoln Electric Co.

Insulators Aid Soldering

by Carl Headapohl,
Westinghouse Electric & Mfg. Co.

By putting the insulating "fenders" on carbon soldering pliers for soldering together a series of wires and copper

blades in voltage regulators, operation time was cut 27 per cent at Westinghouse. Previously, workers assembling the regulators had to stuff thin sheets of mica between the copper blades to prevent them from touching the pliers.

The regulators are used in electrical systems of U. S. warplanes. The accompanying photograph depicts the author of this idea and of this sketch, together with his invention.

[Mr. Headapohl was awarded $660 by Westinghouse for this idea.—Editor]

Welding in the Jungle

by Edward J. Tuckett,
Shipfitter, 1st Class, U.S.N.

Out here in the Pacific, where replacement parts are next to impossible to get and equipment might be tied up for two or three months awaiting parts to arrive, we especially appreciate our Hobart gasoline engine-driven arc welders. We encounter plenty of jobs that back in the States we would consider impossible to return to shape, but here, somehow, we make equipment ready for duty again.

While on one of our repair trips through the jungle we were asked to rebuild five teeth that had been sheared off a small gear on a commutator shaft. Unable to remove the shaft, we wrapped the commutator with sheet asbestos to protect it during welding.

We then discovered that we didn't have any welding rods to do the job with, so I set the welding machine reverse polarity and used bare steel rods to build up the teeth, but as these were too soft to last long, we dressed them with a file and then welded a small bead of Stellite on the surface. Believe it or not, it works perfectly, and the entire job was accomplished in three hours.

Metallurgical Engineering Digest

A Digest of Important Developments in the World of Metals

1 Metal Production

Blast Furnace Practice, Smelting, Direct Reduction and Electro-refining. Open-Hearth, Bessemer, Electric Furnace Melting Practice, Equipment and Refractories. Melting and Manufacture of Non Ferrous Metals and Alloys. Soaking Pits and Other Steel-Mill and Non-Ferrous Mill Heating Furnaces. Steel and Non-Ferrous Rolling, Wire Mill, Pickling and Heavy Forging Practice.

2 Foundry Practice

Melting and Pouring of Gray Iron, Malleable, Steel, Brass and Bronze, Aluminum and Magnesium Castings. Molding, Core-Making, Gating and Risering, etc. Foundry Furnaces, Refractories, Ovens, Molds, Sands, Binders, Auxiliary Equipment and Materials.

3 Metal-Working and Treating

Die Casting. Powder Metallurgy. Drop, Hammer and Upset Forging. Press-Forming, Drawing, Extruding and Stamping. Machining, Grinding and Polishing. Hardening, Tempering, Age-Hardening, Annealing and Malleableizing. Carburizing, Nitriding and Surface Hardening, Heating Furnaces, Refractories, Fuels and Auxiliaries. Welding, Flame-Cutting, Hardfacing, Brazing, Soldering and Riveting. Cleaning, Pickling, Degreasing and Sandblasting. Electroplating, Anodizing, Galvanizing, Metal-Spraying, Coloring, Buffing and Organic Finishing.

4 Materials and Engineering Design

Engineering Properties of Metals and Alloys. Resistance to Corrosion, Wear, Fatigue, Creep, etc. Engineering Design Problems of Specific Industries and Products. Selection of Metals, Metal-Forms and Fabricating Methods. Non-Metallics in the Metal Industries. Applications of Individual Materials. Conservation and Substitution.

5 Testing, Inspection and Control

Specifications. Physical and Mechanical Property Testing and Inspection. Routine Control and Instrumentation. Radiography and Magnetic Inspection, Spectrographic and Photoelastic Analysis. Corrosion- and Wear-Testing. Examination of Coatings. Surface Measurements. Metallographic Inspection and Technique.

1

Metal Production

Blast Furnace Practice, Smelting, Direct Reduction and Electrorefining • Open-Hearth, Bessemer, Electric Furnace Melting Practice, Equipment and Refractories • Melting and Manufacture of Non Ferrous Metals and Alloys • Soaking Pits and other Steel-Mill and Non-Ferrous-Mill Heating Furnaces • Steel and Non-Ferrous Rolling, Wire Mill, Pickling and Heavy Forging Practice

CONTENTS

Electric Arc Hot Topping

Condensed from "The Iron Age"

The chief purpose of applying electric arc to the hot top is to retard cooling in this area, thereby eliminating top shrinkage due to piping as the metal freezes. Results indicate that this method increases good metal obtained in the ingot.

Certain minor difficulties tend to prevent the application of this process to ingots of a standard steel heat but its ability to decrease piping as well is important on heavy ingots and castings where large sinkheads are necessary. It is probable that this method may be applied to special alloy steels.

The International Nickel Co. pours Monel metal, nickel or other high nickel alloy in a pit, big end up, at an average temperature of 2750 deg. F. An 1800 kva. transformer supplies current to six or more electrode trucks which serve the various ingots. The trucks, moved to ingots being poured, support an electrode which is adjusted over the top of ingots.

Current input during the melting down period is about 3000 amp. at 115 volts and the time required to melt the slag is 8 min. Electrode consumption is about 6 to 8 oz. per ton. A 3-in. graphite electrode is used for a 3300-lb. ingot and a 4-in. one for the 7200-lb. ingot.

Reports from Europe indicate that this process has been used on 100-ton steel forging ingots as well as castings and on 200-lb. tool steel ingots. The claim is that piping is completely removed and segregation diminished. The quality of the metal is improved due to the tranquil fusion of the steel and the action of the arc and the flux.

Schoeller-Bleckmann Steel Co., Austria, has applied this process to forging ingots ranging from 10 to 50 tons. Results show a carbon increase of only 0.5 per cent in the upper central portion, elimination of piping and no segregation of manganese or silicon. Sulphur was up by 0.010 per cent in the center while phosphorus was unchanged.

An Eastern steel producer treated a 1 per cent carbon-manganese-molybdenum steel ingot weighing 8000 lbs. The slag consisted of 25 lbs. of a mixture silica and lime. After 1 hr. and 20 min. all metal in the hot top was frozen and the slag froze after 2 hrs. and 5 min. All metal below the hot top in electrically heated ingot was sound.

This process is applicable to roll castings since the castings are large, the number of treating equipment units is small, and the castings are made in dry sand molds which provide good heat insulation around the risers so that the power required is low.

—Geo .F. Sullivan, *Iron Age*, Vol. 151, Feb. 11, 1943, pp. 56-60.

Sleeve Brick and Nozzles

Condensed from "Steel"

Satisfactory sleeve brick and nozzles are necessary for good pouring practice and production of fine quality steel. When these refractories are unsatisfactory, pouring may be defective, or they may produce non-metallic inclusions in the steel. If the fusion point of a nozzle is too high, the stopper head will not seat properly, the nozzle will skull up, and it will have to be burned out. If the fusion point is too low, the nozzle will wash out readily.

In the production of forging grades of steel, the fusion point of the nozzle body should never be below 2600 deg. F. Best consistent results have been obtained with nozzle bodies having fusion points of 2600 to 2800 deg. F. Sleeve brick sometimes are made of the same clay body as nozzles. They should be of higher fusion point, but less dense than nozzles. For safety, the fusion point of sleeve brick should not be under 2800 deg. F.

Grinding, mixing, de-airing, and burning are all closely related in regulating the physical structure of the finished product. Mixing should be thorough to insure uniformity. Sizing and burning depend on the thermal characteristics of the clays.

In steel production, the nozzle and stopper-rod assembly, as well as the ladle, should be heated before tapping. Sleeve brick undergo the tremendous thermal shock of having molten metal rise around them during tapping, and heat is transmitted to the sleeve both from the outside and the bore. Therefore each particle in the sleeve brick must have sufficient room for expansion, and a fairly open body is needed. The best results are obtained with a porosity of 17 to 20 per cent.

The attack of sleeve brick by certain fluid, basic slags may be prevented by throwing a few shovels of fire-clay or sand around the rod before the ladle is pulled. This acidifies the slag about the rod to a composition which will not react with fire-clay. Burnt lime also may be used to thicken the slag and render it almost inactive.

Nozzles must withstand abrasion as well as thermal shock, and consequently must be harder burned than sleeve brick. Nozzles burned too hard will crack on heating. For forging grades of steel, the best results, with respect to pouring practice and quality of product, are obtained with nozzles having 12 to 14 per cent porosity.

Production of high-manganese steels requires specially designed nozzles and sleeve brick. Manganese oxide, which is present, is an excellent flux for fire-clay. Such refractories used in producing high-manganese steel should be of high fusion point, and as hard burned as is possible, with regard to other factors such as cracking and spalling.

—F. F. Franklin, *Steel*, Vol. 112, Apr. 26, 1943, pages 94, 96, 98.

Secondary Metal Production

Condensed from "Mining & Metallurgy"

Secondary metal is metal recovered from commercial scrap. The term "secondary" does not describe any physical characteristics of metals or alloys but refers to their source. In this age, it is not second-rate. It is first-rate metal prepared for a second- or twenty-second-use. It may well be purer than virgin metal owing to the extra passage through refining operations. Each nonferrous metal has its own reclaiming industry and its peculiar methods of handling, although a number of secondary smelters handle a variety of metals under one roof.

Aluminum

War has drastically reduced the number of plants handling aluminum. During 1942 no one could legally melt aluminum scrap without authority from the War Production Board which gave it only to those proving most efficient. In Jan. 1942, only 50 plants produced secondary aluminum ingot, and foundries were not allowed to purchase any scrap, while the primary rolling mills increased their consumption of fabricators' scrap.

Instead of improving low-grade secondary ingot by dilution with pure or low alloy scrap, the Government has called for downward revision of specifications where possible. However, production of secondary aluminum ingot in 1942 was the greatest on record as was the consumption of aluminum scrap. Secondary ingot was allocated in place of primary when possible and specifications for aluminum used in deoxidizing steel were reduced from 94 per cent to 87 per cent aluminum content.

Aluminum has not been commercially refined from alloyed or impure scrap as copper is refined from brass, and a heterogeneous mixture of alloying elements and impurities is building up in certain types of secondary aluminum alloys. After the war the flow of obsolete aluminum expected might exceed the demand for aluminum castings.

Also, the fact that high-grade bauxite reserves here are small may make it necessary to seek other sources of raw material for production of refined aluminum. The aluminum available for salvage at that time should constitute the first source, if refining methods now on the way can be de-

veloped. At present magnesium content can be reduced from high percentages to 0.03 per cent or below.

Copper and Lead

Ingot makers have been unable to find enough scrap of the compositions needed for bronzes meeting Army and Navy specifications. Since Sept. 1941, foundries have been prohibited from buying brass-mill scrap but during 1942 quantities of other copper-brass scrap was allocated to essential production, often in lieu of primary metals or secondary ingot.

The demand for refined copper gave birth to a supplementary "black copper" program conducted by the W.P.B. with the Metals Reserve Co. Smelters having available furnace capacity purchase copper-base scrap on a copper-content basis for Metals Reserve account and smelt it to black copper, sometimes to the blister stage. It is shipped to refineries for the final stages of fire refining and electrolysis to refined copper.

Further increases in the refining of copper from alloy scrap may be expected after the war. Soon after the program started it was apparent the supply would be exhausted in a few months.

Throughout 1942, lead-base scrap was plentiful and assuming that lead and its alloys would be used as substitutes for other scarcer metals, secondary lead smelters continued operations until large inventories curtailed them. Orders limiting the use of lead were somewhat relaxed on Oct. 1, 1942 and it was hoped the Metals Reserve Co. would stock-pile some secondary lead so that the industry might continue operations.

Products of the secondary white metals industry have undergone extensive composition changes in conjunction with the munitions program as well as for conservation of tin. Part of the antimonial lead formerly returned to the storage battery trade now is used to make bullet core wire, and its use as a substitute for zinc die castings is increasing.

Despite the fact that lead in paints is not reclaimed, the proportion of secondary lead from domestic sources is ordinarily greater than that of any other nonferrous metal except tin and nickel. The industry is the most widely dispersed of any in the nonferrous field.

Tin and Zinc

Recovery of secondary tin as refined metal is confined mostly to detinning plants, currently expanded, although remelt tin from block-tin scrap is still available and small quantities are recovered from collapsible tubes. Most frozen tin stocks have been allocated to war production.

Although civilian consumption has been cut to essentials, the average tin content of solders produced by secondary smelters in 1942 was greater than in 1941, and total secondary solders production increased. The tin content of secondary lead-base and tin-base bearing metals was lowered toward the end of 1942.

The term "secondary zinc industry" is applied only to the group of concerns that treat zinc-base scrap and residues. Although the total quantity of secondary zinc recovered as slab or dust by redistillation dropped approximately one-third from the 1941 peak, other secondary zinc products increased. Due to increased activity in brass remelting, unusual quantities of zinc flue dust were generated. The automobile wrecking campaign brought out thousands of tons of zinc die castings and zinc scrap such as in jar caps, battery parts and engravers plates was unearthed.

In peacetime, half of the available zinc is consumed in surface coatings and dissipated. However, much consumed in other uses passes through the usual metal cycle.

—Frederick H. Wright, *Mining & Met.* Vol. 24, May 1943, pp. 227-230.

Beryllium

Condensed from a Report of the War Metallurgy Committee

Beryllium is distinctly a modern development. Its major use is in the manufacture of strong, heat-treated copper-base alloys in which the beryllium content varies from about 0.3 to 2.5 per cent. Its present source is the mineral beryl, found in pegmatite, in which, commercially, the beryllium oxide content is about 10 to 12 per cent, or 4 to 5 per cent of elemental beryllium.

Ore Demand and Supply

About 2500 tons of beryl ore is consumed at present and if supplies are obtain-

able 7000 tons might be used in 1943 and 8000 in 1944. Granting a favorable foreign mining and shipping situation beryl supplies from known sources may aggregate 6000 tons in 1943.

Any large scale expansion rests upon the discovery and concentration of large low grade ore deposits or new discoveries of higher-grade ore. Every effort should be made to increase production from Western Hemisphere mines.

Most beryllium ore has been obtained as a by-product of mica, lithium, and feldspar mining. One half ton of beryl per 100 tons of rock moved is common. A concentrated search for new and better deposits is indicated. The crystals must be large enough for hand sorting as concentration methods for small crystals require development.

The discovery of new deposits of diffuse ores such as helvites or other mineral containing beryllium is needed. These ores are relatively unknown.

Alloys

Beryllium-copper alloys provide a strong, heat-treated metal for electrical contacts, springs, clips, etc. Studies to broaden the use of these alloys because of their valuable properties have now created a demand which tends to exceed the supply.

Virtually all beryllium-copper is now going to vital components of direct and indirect military end products. If insufficient supply causes substitutes to be used, phosphor bronze, aluminum bronze and alloy steel, which it has replaced, will probably be used again. Alloys containing less than the conventional 2 per cent beryllium will suffice for many uses.

Nickel-beryllium alloys have good physical properties but none not obtainable in other alloys of nickel at lower cost.

Magnesium-beryllium alloys are used to some extent for castings but little beryllium is required for this purpose.

The hot strength of aluminum-beryllium alloys is considerably above that of other aluminum alloys. The thermal conductivity is of a high order, and the thermal expansion low.

Other Uses

Beryllium oxide, fired to be used as a refractory material is strong, hard and resistant to thermal shock. Its melting point of 4650 deg. F. is about 900 deg. F. higher than that of alumina. It is the most important fluorescent material used in fluorescent lamps.

Beryllium phosphors, which transform radiation of a given wave length into radiation of longer wave length, are now used in about 92 per cent of the present production of fluorescent lamps. They are also used in X-ray screens, television, and other cathode-ray tubes. The best substitute now known is cadmium but besides requiring 18 times more cadmium oxide than beryllium oxide, the initial light output is 20 per cent lower and the maintenance of initial light output is only 73 per cent of that of the beryllium phosphor at the end of 500 hours.

—War Metallurgy Committee Report to WPB, Information Release No. 3, April 1943.

Deoxidation and the Creep Strength of Carbon-Moly Steel

Condensed from "Transactions," Amer. Society of Mechanical Engineers

Tests made on carbon-molybdenum (½ per cent Mo) steels, deoxidized once with silicon and 1.5 lb. aluminum per ton, another time with silicon and 0.5 lb. aluminum per ton showed the following results on creep behavior.

The steel deoxidized with 0.5 lb. aluminum per ton was found to have a low austenite grain-coarsening temperature, while that deoxidized with 1.5 lb. aluminum per ton had a high austenite grain-coarsening temperature and a range of mixed coarse and fine "duplex" austenite grains. Coarse and fine ferrite grains could be produced in either steel by appropriate heat treatment.

When compared on the basis of similar microstructures, the low-aluminum steel had a slightly higher hardness and lower impact strength than the high-aluminum steel. With a similar microstructure in both steels, the low-aluminum steel was found to be more creep-resistant at 1000 deg. F. under stresses less than 12,000 lbs. per sq. in. and to exhibit a more pronounced decrease in creep rate with time

than the high-aluminum steel.

Three Types Compared

Comparison of the 3 types of microstructures in each steel showed that at 1000 deg. F. the coarse ferrite-pearlite structure was more creep-resistant and showed a decreasing creep rate more consistently than did the ferrite Widmanstätten structure, which in turn was more creep-resistant than the fine ferrite-pearlite structure. Under the same stress; the total deformation in 3000 hrs. was less in the ferrite Widmanstätten structures than in the other two, except in one case.

The coarse ferrite-pearlite structure had lower hardness and lower impact strength than the ferrite. Widmanstätten structure which in turn was harder and had lower impact strength than the fine ferrite-pearlite structure. The coarse ferrite-pearlite structure had higher creep strength than the fine ferrite-pearlite structure at 1000 deg. F., but lower creep strength at 850 deg. F. While coarse ferrite-pearlite had the highest creep strength of the three structures at 1000 deg. F., its initial impact strength was definitely inferior and deteriorated during the creep test.

The fine ferrite-pearlite structure had the highest initial impact strength but the lowest creep strength. The ferrite Widmanstätten structure appeared to be most satisfactory at 1000 deg. F.; its creep strength was good and its initial deformation the lowest of the three structures. Its initial impact strength was almost as high as that of the fine ferrite-pearlite structure, and there was little deterioration of the material, as evidenced by the small loss in impact strength during the creep tests.

Differences Summarized

Summarizing the difference between the two types of steel, it seems that when both steels are heat-treated from just above the A_3 temperature, the ferrite grain size of the low-aluminum steel would be coarser than that of the high-aluminum steel and its creep strength would thus be superior at 1000 deg. F.

Another reason for this superiority lies in the fact that, even if each steel is heat-treated in such a manner that the grain size and microstructure of the two steels are similar, the creep behavior of the low-aluminum steel at 1000 deg. F. is better than that of the high-aluminum steel. The true difference seems, therefore, to be associated with the amount of aluminum added to the material.

—R. F. Miller, *Trans. Amer. Soc. Mech. Engrs.*, Vol. 65, May 1943, pp. 309-316.

Iron Powder Today

Condensed from University of Minnesota "Information Circular"

Iron powder — fine particles of practically pure iron, 99+ per cent — can be produced from the carbonate slates of Minnesota. This powder can be formed directly into finished machine parts. The strength of the product will lie between that of cast iron and steel and will require little or no machining. These products may be plated, galvanized or surface hardened.

It is assumed the powder will eventually be available at a cost of from 5 to 15 cents per pound. The University of Minnesota Mines Experiment Station is working to obtain more accurate data on the cost and on methods required for the production of small commercial parts.

For production of the normal product, the powder is placed in a suitable die at room temperature and subjected to a pressure varying from 10 to 40 tons per sq. in. It is then heated in an oxygen-free atmosphere for one-half hour or longer at a temperature below its melting point. This may be followed by another compression, either hot or cold, to improve the finish, tolerance or strength, or by some other treatment to impart some special property.

At present, the powder is used principally for the manufacture of small parts that would require extensive machining if made from bar stock or castings. Automatic mechanical presses produce the parts at the rate of 20 to 60 per min. After being cold pressed, the briquets are charged into a furnace and heated to a temperature of about 2000 deg. F. A continuous roller-hearth furnace suitable for large scale operations include besides the furnace proper, a cooling tunnel and equipment for producing a neutral or reducing

gas atmosphere to prevent reoxidation.

Powder Quality

Experiments have led to the general conclusions that uniform production depends on uniform chemical and physical properties in the powder. Impurities decrease the strength of the finished product, lessen diversification of the application, and decrease the life of the dies. One die is capable of turning out 50,000 parts, depending on the grade of steel used and the purity of the powder.

Normal operation produces tensile strengths up to 30,000 lb. per sq. in. and post working or hot pressing, up to 38,000. Parts which are too large or cannot be easily ejected from a mold or require high strength, are not satisfactorily fabricated from iron powder.

A comparatively small amount of iron powder is used in the United States at present but the number of small parts for which it is adapted is almost unlimited. Automotive engineers predict the use of 100 lb., instead of the present 3 lb. in every model. Therefore the amount which will be consumed appears to be large but will depend to some extent on the price.

Preliminary calculations on a commercial plant capable of producing 100 short tons (200,000 lbs.) of powder per day indicate the operating cost would be about 5 cents per pound. The ore to be utilized has no value at present. After going through a primary and secondary crushing plant the ore must be ground to —48 mesh and filtered. Digestion is then accomplished in two stages by agitation of the ore with dilute sulphuric acid and the iron will be crystallized out as copperas.

The final purity of the product depends mainly on dehydration and calcination by which all sulphur is removed. After washing, the iron oxide is agglomerated by heating in an oxidizing atmosphere. Metallization of the iron in the agglomerated oxide may be done in a shaft-type furnace using blue water gas (hydrogen plus carbon monoxide). It must be cooled in oxygen-free atmosphere.

After cooling the iron may be ground in a hammer mill, ball mill or disc pulverizer. The final iron powder will be delivered to manufacturers in drums and can be charged directly into hoppers.

—C. V. Firth, Univ. of Minnesota. Information Circular No. 3, Mines Experiment Station, May 1943.

New Salvage Manual

The Industrial Salvage Branch of the Salvage Division, War Production Board will distribute within the next month its new 300-page "Salvage Manual for Industry." The book contains 25 chapters embracing all practical phases of industrial salvage activity from the organization of a plant salvage department to methods of segregating, processing, reclaiming and identifying various types of scrap. Both metals and non-metals are covered.

The book, prepared by a staff of salvage experts from industry and industrial-magazine editors, will be distributed without charge to thousands of plant salvage managers. Copies remaining after the initial distribution will be sold at a moderate price.

Foundry Practice

2

Melting and Pouring of Gray Iron, Malleable, Steel, Brass and Bronze, Aluminum and Magnesium Castings • Molding, Core-Making, Gating and Risering, etc. • Foundry Furnaces, Refractories, Ovens, Molds, Sands, Binders, Auxiliary Equipment and Materials

CONTENTS

Liquid Pressure in Casting

Condensed from "Foundry Trade Journal"

The best known methods of exerting more than normal pressure on solidifying metals are by the various centrifugal and pressure die-casting processes. In these processes, pressures up to 100 atmospheres result from the force employed. In the year 1865 J. Whitworth introduced a method of casting steel ingots under pressure.

A similar process is stated to have been used by Bessemer as far back as 1856. The process consisted of pouring metal into a mold made of a strong steel jacket with a more or less porous lining. Steel was run into the jacketed mold, and great pressure put on it by means of an hydraulic ram, the pressure reaching up to 20 tons per sq. in. of horizontal section.

Pressure by Gases

Other means of exerting pressure are by employing carbon dioxide, air and steam. The pressures to be considered in a mold are, firstly, that of liquid pressure, which embraces static and streaming pressures or momentum, and secondly, gas pressure. Usually calculations are based on liquid pressure, but while gas pressures are difficult to ascertain, it is a force which must not be ignored, otherwise failure may follow.

When moisture in a mold is converted to steam and gas and the temperature further raised quickly in contact with molten iron, the increase may be of the order of several thousand times the original volume, depending upon the temperature gradient. The sand of the mold will hold in gas-forming elements, such as metallic oxides, combustible material and more or less moisture to which must be added the air occupying the mold cavity.

A larger portion of the gas formed will be evacuated through the sand pores and artificial vents provided by the molder; further quantities of gas pass through filling of the mold, when the riser gates are just closed by the metal, gas pressure will exert a force in addition to that of liquid pressure. The degree of this pressure can only be allowed for empirically from acquaintance with the construction of molds against fluid pressure.

Minimum Allowance for Gas Pressure

The author would suggest a minimum allowance of an additional 10 per cent of lift on an average mold for gas pressure. Any pressure exerted will depend upon the height of the column of metal in the down-gate and pouring basin and not upon the actual volume. With a molten metal, however, the time during which it remains liquid is also important since pressure can only be maintained to act through feeding heads to allow for liquid shrinkage, if the area connecting the header with the casting has sufficient body and volume and delays freezing until the casting is satisfied.

Let us consider the mold which has the down gate of 1 sq. in. section fed from a pouring basin. The top of the pouring-bush metal is 12 in. above the joint line and the height from the effective base of the down-gate to the top of the pouring-bush metal is 36 in. The castings then are subject to the 12-in. head from the joint face to the upper surface of the pouring basin.

Variations in Pressures

Pressure will vary according to the densities of the alloy or metal. For the cast iron castings with the upper faces 12 in. sq., taking cast iron at 0.26 lb. per cu. in., pressures imposed will be as follows:

On the upper face at the joint:
$12 \times 12 \times 12 \times 0.26 = 449$ lbs.
On the bottom of the mold
$12 \times 12 \times 36 \times 0.26 = 1348$ lbs.

For other metals multiply the cast iron calculations by the factor given below:

	Multiply by
Steel	1.09
Lead	1.58
Leaded bronze (10% Pb)	1.25
Phosphor bronze	1.20
Gun metal	1.18
Brasses	1.16
Aluminum bronze (10% Al)	1.08
Aver. aluminum alloy	0.37
Aver. magnesium alloy	0.24

When calculating the fluid pressure on molds and cores, it is necessary to allow for the generation of the rapidly expanding gases. An average of 10 per cent is

needed for gas pressure. The momentum of the metal when meeting upper faces of the mold needs further allowance of from 5 to 20 per cent depending upon the open area of the mold and the speed of pouring. Therefore, between 20 to 25 per cent should be added to the calculated pressure for variables and contingencies.

The influence of fluid pressure on soundness, influence of atmospheric pressure ("blind risers"), strength of molds and cores to resist fluid pressure, etc. are also discussed by the author.

—E. Longden, *Foundry Trade J.*, Vol. 70, May 20, 1943, pp. 45-50, 52; May 27, 1943, pp. 65-69.

Modern Gray Iron Manufacture

Condensed from a paper for The American Foundrymen's Assn.

Sand reclamation, sand control, synthetic sands, salvage of materials, modernized mechanical equipment, improved methods of drying cores and molds, better use of gates and risers, directional solidification, scientific cupola practice, the importance of pouring temperatures and speeds, and use of alloys are developments in the gray iron foundry industry that have proved their worth. Castings ranging from a few hundred pounds to 125 tons are made in flasks and pits, using dry sand or loam.

Use of synthetic sand, made from reclaimed molding and core sands, has resulted in adoption of one facing sand and one heap sand for all dry sand work, used for molds and cores alike. A standard blocking has been adopted for all molds and cores. Portable mold dryers, burning a mixture of air and gas, has replaced salamanders and perforated pipes.

Standardized gates for each type of casting have been fixed upon. Neck type risers have been adopted, and cleaning costs have been reduced because of the ease with which they are broken off. Pit bottoms made up with a 4- to 6-in. coke bed, and with good sized vent pipes about 6 ft. apart, have helped to solve venting problems.

Metal is melted at 2800 deg. F. or over, and poured at 2500 deg. F. to 2700 deg. F. The desired pouring temperature is predetermined for each type of casting, and pouring speeds of 10 to 15 tons per minute are maintained.

Castings are allowed to cool in their pits or flasks for from one day to three weeks, depending upon size and weight. Adhering sand is removed with a broom or wire brush, and all sand is returned to the storage pit.

A standard procedure is followed before starting work upon any large casting. The dimensions, type of casting, design details, molding methods, metal thickness, and casting procedure are decided upon, and copies of this instruction sheet are issued to the foremen assigned to the job.

—Samuel Appelby, American Foundrymen's Assn., Preprint No. 43-13.

Centrifugal Casting

Condensed from "The Iron Age"

While the broad principles used in centrifugal casting were outlined in a British patent of Eckhardt, in 1809, all major advances have been made within the past 20 years. Railway car wheels were probably the first steel product cast by this method. Ground manganese was thrown into the first metal going into the mold, forming the rim and flange, while the plate and hub were of mild steel. Molybdenum-vanadium steel, cast into guns in horizontal cast iron molds at Watertown, Mass. arsenal, and gear castings made in sand molds were recent developments.

Centrifugal casting may be simply described as the casting of metal under centrifugal force developed through high rotative speeds of a special mold. The processes may be divided according to (1) the method of mold rotation, (2) the method of pouring, and (3) the construction and form of the mold.

If the casting has a depth length greater than about 2 ft., or if it is produced entirely in a die without core inserts, it will usually be made in a horizontally rotating mold. Most steel castings produced in sand molds or core assemblies, unless very long, are vertical rotated.

Horizontally rotated molds are poured from a pouring box with spout extending into the mold. Steel is poured through a

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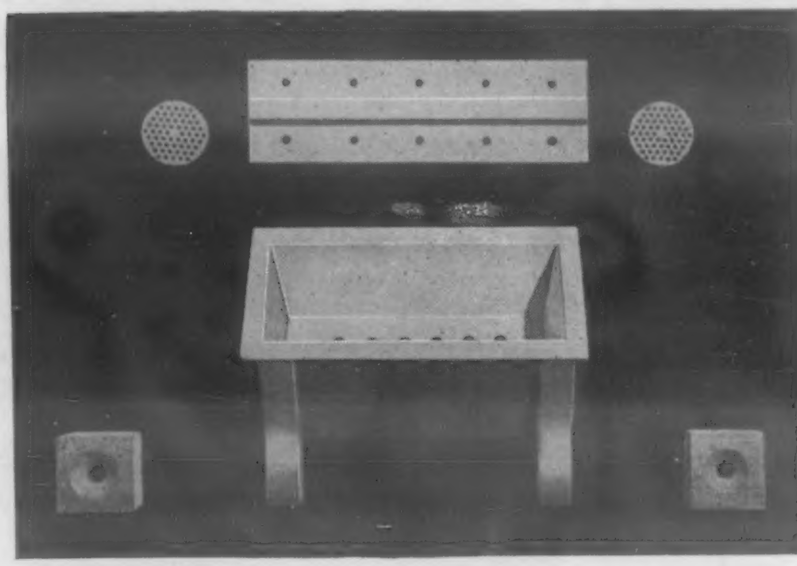

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central opening into vertically rotated molds, in some cases filling the mold before centrifuging. Die molds are made of steel or cast iron, a chromium-molybdenum steel often being preferred. Most sand molds are core assemblies, although green sand, air dried sand or oven dried sand are also used. Speed of rotation varies from about 50 to 1200 r.p.m., with 150 to 300 r.p.m. most common.

There are three general types of these castings: (1) true centrifugal castings, made by pouring metal into a rotating metal die; (2) semi-centrifugal or profiled castings, made in dies, sand or core assembly molds, where the inner surfaces of the casting are formed by cores; and (3) pressure castings, in which centrifugal action is used to force molten metal into the mold.

Yields may be increased by use of centrifugal castings, due to elimination of feed heads, risers, etc.

At Maynard Electric Steel Casting Company, Milwaukee, 36 in. and 46 in. spinner tables, driving from 3 h.p. motors through rope drives, turn from 50 to 450 r.p.m. An average yield of 80 per cent is obtained, with castings of from 30 to 500 lbs.

Wehr Steel Company uses vertical machines driven from single speed motor through pulleys and rope drive. Speeds vary from 150-250 r.p.m. Higher costs are offset by better castings and the higher yield of 71.3 per cent.

—C. W. Briggs, P. C. Power, and A. T. Baumer, *Iron Age*, May 13, 1943, pp. 53-58.

Sound Aluminum Castings

Condensed from "The Foundry"

The physical form and cleanliness of aluminum scrap are important owing to their effect on the quality of the resulting casting. Finely divided material should be removed because it will result in more dross. Contamination by oil, moisture corrosion, etc., if not removed, will result in excessive gas.

One of the troubles is pinhole porosity from hydrogen gas. One method of removing hydrogen is by the use of a reagent such as chlorine or nitrogen, which is introduced into the molten alloy. The fluxing gas and tools used for introduction should be free from water.

Introduction of the gas is accomplished through an iron pipe coated with a refractory clay composition to avoid iron pick up by the aluminum alloy. The tube should reach to within 2 in. of the bottom of the pot or crucible. The time of gassing is 5 to 10 min./100 lb. of metal and the temperature should be 1250 to 1350 deg. F.

Another method of removal is to melt the aluminum alloy, then allow it to freeze in the pot, and remelt to pour into castings. This may be more costly than a suitable fluxing procedure.

Salt fluxes such as aluminum and zinc chlorides, etc. may be used for degassing, but they may not be as effective as gas fluxing. Zinc chloride should not be used in large quantities since it is reduced to metallic zinc and alloys with aluminum. To obtain full benefit from salt flux, it preferably is introduced at the bottom of the crucible.

Molten metal can pick up the gas very easily. This can be held to a minimum by permitting the metal to stand without agitation. Also, in transferring the metal, keep the stream as short as possible. It is also essential that the temperature of melting and holding should be no higher than necessary.

Sand condition, particularly with reference to green sand, is important in maintaining a low gas pick up. Sand should be worked as dry as possible. Permeability should also be high.

Non-metallic inclusions should be removed by the sink or float method. Unfortunately the specific gravity of the inclusions is close to that of aluminum, and separation is much slower. The use of gas fluxing or salt fluxes aids the separation procedure.

Skim gates or cores are an aid in preventing oxides and dross from entering casting cavity. The riser should be close to the casting. Application of the counterflow principle in the runner system aids in removing dross and oxides. Use of troughs or casting basins insures clean metal.

—Edwin Bremer, *Foundry*, Vol. 71, June 1943, pp. 126-128, 215-216.

Metal-Working and Treating

Die Casting • Powder Metallurgy • Drop, Hammer and Upset Forging • Press-Forming, Drawing, Extruding and Stamping • Machining, Grinding and Polishing • Hardening, Tempering, Age-Hardening, Annealing and Malleableizing • Carburizing, Nitriding and Surface Hardening, Heating Furnaces, Refractories. Fuels and Auxiliaries • Welding, Flame-Cutting, Hardfacing, Brazing, Soldering and Riveting • Cleaning, Pickling, Degreasing and Sandblasting • Electroplating, Anodizing, Galvanizing, Metal-Spraying, Coloring, Buffing and Organic Finishing

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Phosphate Films for Cold Drawing

Condensed from "V.D.I. Zeitschrift"

Lubricants are used to reduce friction between the drawing die and the blank by interposing a parting layer between two similar metallic surfaces. The most important layers of this kind are liquid films, oils, greases and soaps, the effect of which can often be increased by the presence of solid coatings such as limewash, metallic oxides, copper and lead. These solid coatings act by retaining the liquid film on the metallic surface by adsorption and by preserving the continuity of the parting layer even where the lubricant film is interrupted owing to excessive pressure.

The present study dealt with phosphate coatings consisting of insoluble mixed Fe-Zn or Fe-Mn phosphates. The structure of such coatings is considerably influenced by the conditions of formation. Fine grained phosphate coatings appear to be most suitable for cold drawing; coarse grained coatings composed of lamellar and acicular coatings have less effect.

A phosphate coated surface retains about twice as much oil as does a bare surface. One of the reasons is, of course, the greater superficial area of the coated surface; it is as yet uncertain whether the greater adsorption is due to the presence of the phosphate. Increasing the thickness of the phosphate coating has no effect on the capacity for oil adsorption; most of the oil is probably simply retained by adhesion on the roughened surface.

The efficiency of a solid coating in parting the work from the tool during successive deformations depends essentially on its ductility. Although phosphate coatings show a brittle fracture in the usual rupture tests, the crystals of the coating are considerably stretched in the drawing process. The pressure and temperature conditions in the draw are therefore decisive for the ductility of the coating.

Laboratory tests with phosphate coated steel tubes drawn dry offer direct proof of the value of the coating as an efficient parting layer. Although the original phosphatized surface is dull and unpolished, it assumes an increasingly bright finish. The metal itself also becomes progressively smoother in the course of drawing.

—A. Duerer and Others, *V.D.I. Zeitschrift*, Vol, 86, Jan. 10, 1942, pp. 15-18; as translated and slightly condensed by L. J. Goodlet, *Sheet Metal Inds.*, Vol. 17, June 1943, pp. 1025-1027.

Spot Welding Aluminum-Clad Steel

Condensed from "The Iron Age"

This article gives results of research conducted to develop process specifications for the spot welding of annealed aluminized steel. This material is a substitute for stainless steel in aircraft construction.

Spot welding of the following combination of materials was studied: (1) 0.018 in. aluminized steel to 0.018 in. aluminized steel; (2) 0.018 in. aluminized steel to 0.24 in. aluminized steel; (3) 0.024 in. aluminized steel to 0.024 in. aluminized steel; (4) 0.018 in. aluminized steel to 0.018, 0.024 and 0.037 in. 302-1A stainless steel; (5) 0.024 in. aluminized steel to 0.018, 0.024 and 302-1A stainless steel; (6) 0.018 in. aluminized steel to 0.018, 0.024 and 0.035 in. mild steel; (7) 0.024 in. aluminized to 0.018, 0.024 and 0.035 in. mild steel; and (8) 0.018 and 0.024 in. aluminized steel to stainless steel and cadmium plated anchor nuts.

Results showed that spot weld shear strengths well above the Army minimum for annealed S.A.E. 1010 steel could be obtained with the two gages of aluminized steel for all combinations. More than 100 welds could be made without cleaning the electrode tips.

It was not feasible to weld stainless steel and cadmium plated mild steel nuts to the aluminized steel in the ordinary manner. Excessive flashing, burning and cracking of the nuts, rapid tip deterioration, tip sticking and inconsistent welds were obtained.

Discoloration and film had to be removed, perhaps caused by corrosion, which appeared on the aluminized steel sheets. Flashing is reduced, danger of burning the material is prevented and consistency is improved if the surfaces are clean and bright. Any method of cleaning and etching Alclad for spot welding will also be satisfactory for aluminized steel.

Electrode tips of high strength copper alloy are satisfactory. One tip should be 3/16 in. in diam. and 3 in. radius; the other 3/8 in. in diam. and 10 in. radius.

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than 100 kva. rating is recommended. It should be equipped with electronic type control.

The following procedure should be followed; (1) Adjust current duration to 2 cycles; (2) Adjust squeeze time and hold to values that give the desired rate of welding; (3) Adjust electrode forces to given values for the particular combination being welded; and (4) Adjust transformer tap setting and heat control dial for a low value of current. Make 25 to 30 welds in scrap material, then increase current until flashing and spitting occurs. Then reduce it gradually until spitting stops.

To obtain good shear strength and weld slug penetration, weld strengths should be high. Cadmium plated mild anchor nuts can be welded with an electromagnetic type stored energy machines.

—John D. Rosenblatt, *Iron Age*, Vol. 151, June 1943, pp. 72-74.

Flame Hardening Tank Parts

Condensed from "The Iron Age"

Each turret has rings which fit inside one another in such a way as to permit the turret to swing freely through the 360 degrees of a circle. To insure against failure under various climatic and operating conditions, the Army specifications for these rings call for bearing races to be hardened to a specified depth. To meet these specifications flame hardening seemed to be the best method of hardening the ring races.

As purchased from the mill, the rolled steel section is approximately the contour of the finished part and is alloy or carbon steel, depending whether the part is to be load bearing or not. After forming into a ring, flash welding, reheating, sizing and flattening, the rings are machined to shape.

Flame heads used are generally the shape of the face in the ring. In addition to having flame ports, they also provide for the quenching of the race by having ports through which quenching medium is sprayed onto the race after it passes the flame.

Holding the work in a vertical plane was advantageous by increasing the ease and speed with which work could be loaded and unloaded from the jig tables. Another advantage was the elimination of distortion in the flame hardened rings through the ability to quench the rings by immersion in the tank full of cooling medium.

After the spray quench, the ring passes into a tank bath which dissipates the heat that remains in the ring and jig. From the tank, the coolant is recirculated through a filter to remove dirt and then it is pumped back to the flame hardening head.

Surface speeds for hardening the various rings range from 6 to 7.5 in. per min. Oxygen pressures are 8 to 18 lbs. depending upon shape and size of the area being hardened. Acetylene pressure should be held constant at 5 lbs. This method is used by the American Welding & Mfg. Co.

—Thomas E. Lloyd, *Iron Age*, Vol. 151, Mar. 25, 1943, pp. 64-65.

Grinding Fine Surfaces

Condensed from "Machinery"

With fine grinding it is possible for bearing surfaces to be made so smooth that no slow and expensive run-in time is necessary. Fine surfaces are also necessary for air- or fluid-tight seals, as in shock absorbers for airplane landing mechanisms and gun recoil assemblies. Some non-bearing surfaces such as airplane connecting rods, subject to heavy recurring stresses, need to be even smoother.

Good Surface Quality

A high luster does not necessarily indicate a good surface quality. Luster is often secured by burnishing with a dull grinding wheel. This bends down the high ridges and fills the valleys, but in use the bent material flakes off and the underlying rough surface appears. Silicon-carbide abrasive wheels also make a poor surface that appears lustrous. Aluminum-oxide wheels, on the contrary, give a much better surface although it has a dull appearance.

A committee of the American Standards Association has recommended the "root mean square" (r.m.s.) method of evaluating surface roughness. Instruments are available that give direct readings in r.m.s. values in micro-inches. Others draw a profile curve which can be used directly or to calculate the r.m.s. values. These provide a method of measuring that has a definite value and can be specified on a drawing or over the telephone.

The more common method is judging by eye and drawing the fingernail across the surface. It is claimed that, taken in connection with standard reference pieces for given r.m.s. roughness, this permits inspection with close limits and enables the designer to choose the type wanted from the specimens.

If grinding machines are kept in the best possible condition, surfaces of an even better quality than 2 micro-inches can be secured without lapping or honing. The average part can be finish-ground to 4 to 5 micro-inches r.m.s. on a high-production basis.

Causes of Defects

When dimensional inaccuracy, surface roughness and such defects as burns, checks, flats, scratches and chatter marks appear, one or more of the following conditions may be the cause.

(1) *Inadequate Power*—which may cause the grinding to be uneven, the work burned, or the wheel loaded. Discoloration shows burning. A loaded wheel is shown by metal lodged on the abrasive grains or in the pores. The same effects may be caused by too hard a wheel, the wrong coolant or friction in the machine.

(2) *Wheel-Spindle in Poor Condition*—which may cause burns, scoring or chatter marks. Short, close, evenly spaced chatter marks or isolated deep scratches indicate a worn or loose spindle. That it is out of round is shown by more widely spaced chatter marks.

The spindle bearings should be of high-grade babbitt, as this gives a closer running fit when heated. The machine


HA-HA! HE THOUGHT A SNAKE BIT HIM! I DON'T SEE HOW A GUY COULD BE ABSENT-MINDED ENOUGH TO THINK THAT A SNAKE WOULD BE IN A BIG MODERN PLANT LIKE THIS!
THAT'S JUST TH' REASON! IT'S SO MODERN THAT ONLY A FEW MONTHS AGO WE WAS PICKIN' WILD BERRIES RIGHT ABOUT HERE--AND THERE WAS SNAKES IN TH' BUSHES!
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3-5

should be given a preliminary run before a job to heat up the bearings.

In reconditioning grinding machine spindles it is necessary to scrape the bearings if the assembly has become out of alignment. If the spindle is badly out of round it must be reground, then lapped in to its bearings. If only slightly out of round, lapping will rectify it.

(3) *Vibration*—which, if in the machine, causes regularly spaced chatter marks and results from misalignment, loose couplings, or the motor and spindle being out of balance. If in the building, the chatter marks are spaced synchronously with the vibration. With a heavy machine, a separate foundation or removal to another part of the building may be necessary. With a light machine, vibration dampers are useful.

(4) *Belts of Uneven Thickness or Pliability*—cause chatter marks that are widely spaced and regular. Endless belts will prevent marking by a metal belt lacing.

(5) *Loose or Out-of-Balance Idler Pulleys*—also cause widely spaced and regular marks. The pulleys should be balanced, fitted with new bushings and lapped to their shafts.

(6) *Backlash in Drive Gears*—causes long, widely spaced chatter marks. The old gears should be replaced or a change made to belt drive.

(7) *Loose Pulley of the Spindle*—results in marks similar, but more frequent, to those made by a belt lacing.

(8) *Worn Traverse Drive Parts*—cause deep scratches and should be replaced.

(9) *Misalignment of Headstock and Tailstock or of Wheel-Head and Work*—causes spiral traverse marks of the same lead as the rate of traverse.

(10) *Miscellaneous Causes*—result in various inaccuracies. Uneven pressure on the driving points makes the work out of round. Faulty setting of the head and tailstock, worn ways, or loose spindle bearings make the work out of parallel.

—H. J. Wills, *Machinery*, Apr. 1943, pp. 202-204; May 1943, pp. 169-172.

Reclaiming Tungsten Carbide Chips

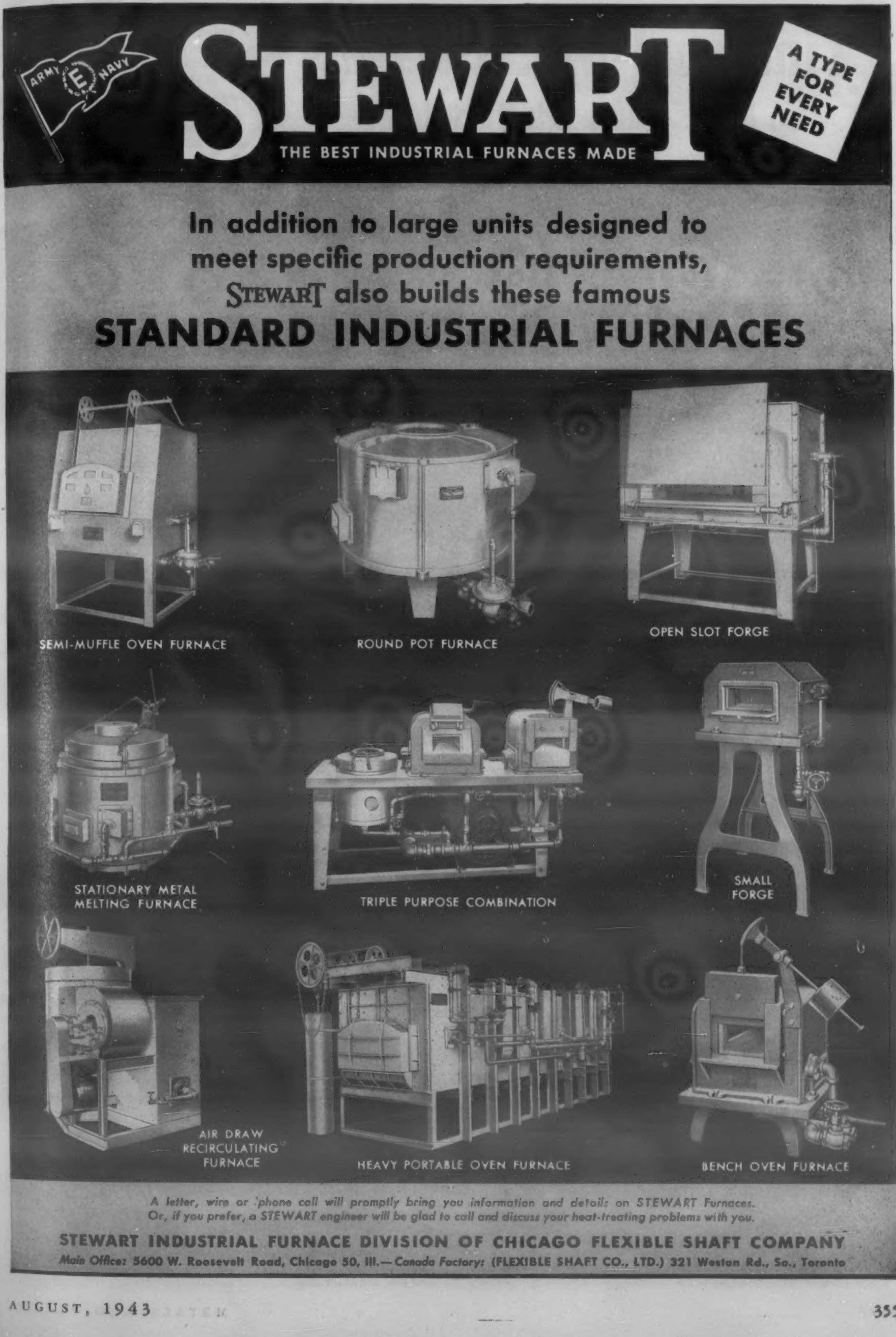
Condensed from "Automotive and Aviation Industries"

The Aircraft Engine Division of the Ford Motor Co. reclaims tungsten carbide tool tips that have served their purpose.

The tip is kept for an hour in a concentrated bath of nitric acid at a temperature of 150 deg. F. After it is washed in water it is possible to remove it from the shank with a slight tap. Contaminating iron and brazing material are removed in a bath composed of equal parts of nitric acid, hydrochloric acid and water. Next the chips are washed in a caustic bath. Titanium and tantalum chips are removed in a hydrogen-atmosphere furnace at 240 deg. C. They can be easily separated because they turn brown while the tungsten chips remain gray.

After this the carbide chips are pulverized in a 100 lb. Bradley power hammer and drawn off by the air current of a centrifugal exhauster, through a cloth filter. The dust settles in a trap from which it is recovered.

Oxides are reduced by placing the pul-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verized tungsten carbide in carbon boats in a hydrogen-atmosphere furnace at 1500 deg. F. for 20 minutes. The powder is then put through a 400 mesh sieve and is ready for use. What does not pass through is repulverized. A binder of a 3½ per cent solution of paraffin wax in trichlorethylene is added and the mixture is dried for 2 hours in an oven at 140 deg. F.

To form into shapes, the mixture is compressed in steel molds under a pressure of from 5 to 20 lb. per sq. in. The lower pressure range is generally used as the higher, although giving higher density, causes lamination.

Next the tungsten carbide is covered with aluminum oxide. After preheating to drive off the wax, it is "soft-sintered" at 1600 deg. F. for 20 min. It is then "chalklike" and can be cut with a saw, file or grinding wheel. It is cut to 17 per cent oversize in all directions to allow for shrinkage in the final sintering. This is done in carbide boats in which the shapes are covered with flake graphite and passed through a hydrogen-atmosphere furnace at 2760 deg. F. for 20 minutes at heat. The shapes are then ready for brazing to tool shanks, die holders etc.

—*Automotive and Aviation Industries*, May 1, 1943, p. 42.

Machine Flame-Cutting

Condensed from "Welding Journal"

Mechanized oxyacetylene cutting has become indispensable for the sizing and shaping of steel plate for war equipment. One of its most important uses is the shaping and edge preparation of steel plates for combat vehicles.

Multiface Cutting

"Multiface cutting" is an outstanding advance on old methods. It involves the use of a series of cutting nozzles in a cluster, located so that any required edge contour can be cut with a single passage. In preparing a double bevel with nose, for instance, the first nozzle produces the underbeveled surface; the second, the land or nose surface; and the third, the top beveled surface.

To maintain the nozzles at a fixed distance above the plate, which is rarely flat, they are supported in a block or fixture. This, replaceable for different edge-contour requirements, is attached to a vertical spindle, at the bottom of which is a plate-riding wheel. At the top and bottom of a sleeve enclosing the spindle are four spring-loaded rollers. This permits free vertical motion of the spindle without side play and the rollers take up any wear or other effect due to expansion or contraction. Preheat gases fed to a mixer, and cutting oxygen to a distributing manifold, are distributed through tubes to the nozzles.

Adjustable Nozzle Block

For applications requiring a large number of different edge contours the fixing block is supplemented by an adjustable one. This consists of a body casting including a vertically disposed socket for the square cutting nozzle head and nozzle, and two horizontally disposed sockets into which are set the adjustable bevel-nozzle

holders. These are made up in two parts, the nozzle holder proper and the extension bar. The holder can be adjusted to any desired angle and spaced as desired in reference to the squaring nozzle. Thus any beveling combination involving three faces can be obtained. The combined heat generated by the nozzles permits increased cutting speed. Irrespective of this and the reduced required setting-up time, an edge having a double bevel with nose can be produced by this method in one-third of the time required for the single blowpipe, multipass method.

With bevel angles greater than 45 deg. an auxiliary cutting jet provides sufficient preheat to ensure uniform results. In making a 57 deg. under-bevel with nose preparation, the leading or auxiliary nozzle is set at 45 deg. This cut heats the surface so there is no difficulty in carrying the shallower bevel with the succeeding cut. The heated fin produced between the two jets offers no obstacle to penetration by the jet from the vertical or squaring nozzle.

Propulsion Units

In multiface cutting two types of propulsion units are used: A heavy-duty tractor-type machine and a bridge-carrier type named the "flame-planer." With the first the track is located in a stationary position and the plate brought to it and lined up with the edge to be cut parallel to the track. A number of units can be installed and the plate fed to the cutting positions by roller or castor conveyors. For a large number of plates of the same detail, track setups can be made for the shape required.

For producing large quantities of various sized plates, wholly, or mostly, rectilinear, the "flame-planer" provides the most efficient unit for propelling the equipment. It consists of a bridge-type carriage driven on rails spaced to accommodate the widest plate. The motor and governor are of the same type used in other oxyacetylene cutting machines. Guide rollers operating on a V-rail insure straightness of longitudinal travel. As many plate-edge attachments and standard cutting blowpipes as are desired may be mounted on base plates, adjustable for accurate spacing.

Use of the Flame-Planer

For cutting cookie sized plates, where only one finished piece can be obtained, the flame-planer is most efficient if two of the cutting attachments are set up to prepare two opposite edges and the other two units for the two remaining edges. A number of cookies are laid on the supports. Two cutting devices cut two sides of each plate simultaneously. As the carriage passes from one plate to the next, the cut plate is turned 90 deg. After the carriage runs the length of the table it is returned and the newly aligned edges are cut simultaneously with the other two cutting attachments. This gives close tolerances and high rates of production.

In cutting a number of pieces from a large sheet, the most efficient arrangement is that of a cross-cutting carriage in combination with the one just described. This combination has been used effectively in shipyards for a square-edge and bevel preparation of large plates.

On a number of the lighter plates used in welded ship construction, a square edge is required for Union-melt welding. For this the "rip and trim" method uses two nozzles, the first to rip the steel as in rough-machining and the second to smooth the rough surface. Speeds as high as 70 in. per minute on 1/4 in. plate and 40 in. on 3/4 in. plate have been obtained.

Bevel Cutting Attachment

A shape-cutting machine employing a templet formed to the plate shape is used for plates involving simple beveling or a number of changes of direction in cutting. Where different bevel angles are used in a single piece a continuous templet cannot be employed. To overcome this, a bevel-cutting attachment has been developed. It provides for rotation of the blowpipe nozzle about a fixed point so that the cutting stream impinges at this point irrespective of the bevel angle. The device also rotates about a center point so that the point of impingement is not affected by the direction of cutting. There is a segment for readily and accurately setting the bevel edge, a spring-loaded vertical slide which maintains the desired setting as the unit is raised or lowered to compensate for undulations in the plate, and an angle selector for easily rotating and setting the devise.

—H. E. Rockefeller, *Welding J.*, Vol. 22, Feb. 1943, pp. 93-99.

Post-Treatment of Welds

Condensed from "Sheet Metal Industries"

The strength of a copper joint can be increased by cold hammering. After hammering the welds should be annealed if possible to relieve strains.

It is also beneficial to hammer welds in aluminum to relieve contraction stresses set up during cooling and to reduce surface porosity. However, the strength is not increased by the hammering. Welding heat-treated aluminum alloys should be done in one pass, as a second weld layer is undesirable, especially on vessels required to be leakproof. For best results on heat-treatable alloys, the whole object should be heat treated after welding. If no subsequent heat treatment is given alloys such as duralumin, the joints are comparatively weak and have very little ductility.

The fusion welding of magnesium alloys does not differ radically from that used in welding aluminum. Where possible the fusion weld should be annealed and post-treatment is of extreme importance. Also, hammering should be given at a temperature of 570 deg. F. to break up the transition in structure between the cast metal and the parent metal and to render the joint more nearly homogeneous.

Finished welds should be thoroughly cleaned and then immersed in potassium bichromate (15% K) solution, rinsed, dried and immersed for 2 to 3 min. in 15 per cent nitric acid to which has been added a small amount of potassium bichromate. This treatment dissolves the last traces of surface flux and gives protection to the surface. In tests on rolled Elektron taken across the line of welds,

unhammered welds gave 50 to 60 per cent of the strength of the unwelded sheet, whereas hammered welds gave 75 to 90 per cent.

After mechanical treatment by hammering, fusion welds in brass should be annealed.

Fusion welding tends to lessen the anti-corrosive properties of stainless steels (both to the air hardening and non hardening types), but this can largely be neutralized by suitable subsequent heat treatment (Abstractors note: In the case of 18-8 stabilized with titanium or columbium, this subsequent heat treatment can be eliminated).

—A. J. T. Eyles, *Sheet Metal Inds.*, Vol. 17, Apr. 1943, pp. 691-692.

Automatic Electric Welding

Condensed from "The Welding Journal"

The Unionmelt automatic electric welding process is being applied to a variety of structures and to steels of many analyses. It is similar to hand arc welding only in that an electrode in the form of a rod is fed by controlled means into the welding zone and metal is discharged from the tip into the seam. Because of the high currents used, it requires a different mechanical setup. With a 1/4-in. welding rod, the current ranges from 700 to 1400 amp. The resulting large body of molten metal is highly fluid and backing must be used to keep it from falling through the bottom of the weld.

Weld Backing

Three general types of backing are: (1) Copper strips, removed after the weld has been completed. (2) The use of a layer of Unionmelt granules held up under pressure to the underside of the weld. (3) The use of a steel strip tack welded by hand to the bottom surfaces of the two pieces to be joined.

The most common use of copper strips is in pipe welding. The extensive, repetitive operations justify the expense of a suitable jig to clamp the pipe in place and hold the strip to the underside of the weld. The rougher appearance of the back resulting is accepted by pipe inspectors. It is also feasible to use these strips on circumferential seams in conjunction with an expanding ring arrangement.

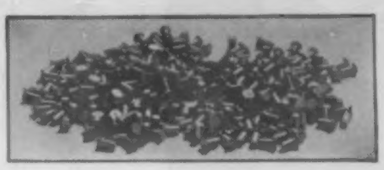
Carefully controlled conditions in using a layer of Unionmelt granules as backing, give a small bead on the inside, smooth and suitable in contour. There is no satisfactory method of holding the layer on the inside of a circumferential pipe seam, although it has been done in welding large cylindrical pressure vessels.

In ship construction the method of making butt welds in ship plate is to butt the square-cut edges together and make a first pass on one side so that it penetrates halfway through, and a second pass on the other side. The unwelded portion thus makes a backing for the first pass, and the weld made by the first pass backs the second. It is practical on plate up to 5/8 in. in thickness.

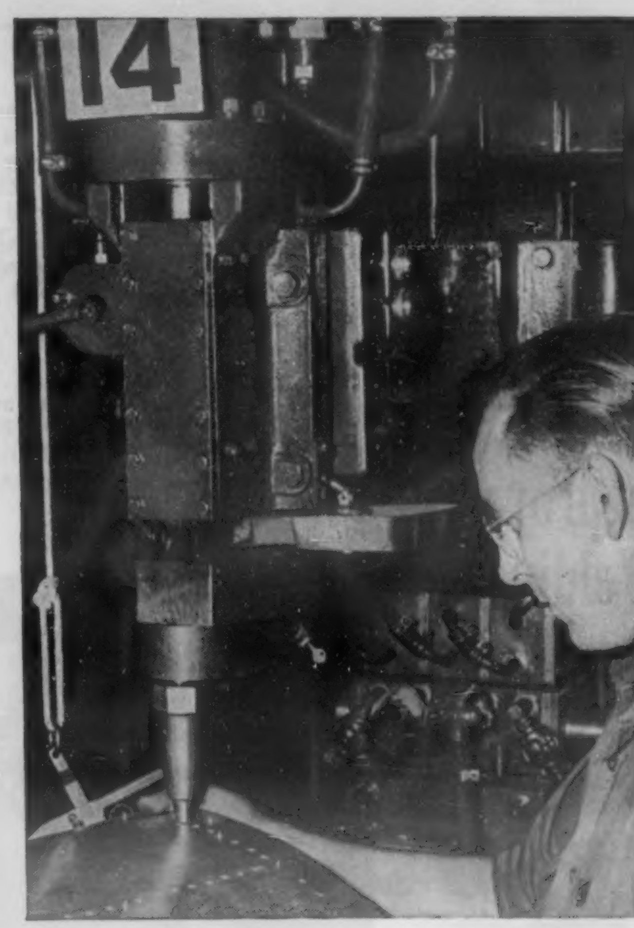
In the manufacture of pressure vessels, backing is eliminated by the use of the double-vee method of edge preparation.

The Emphasis is on Saving

Mallory Tips Help Save Man Hours and Machinery in Spot Welding the P-40



Spot welding saved all these rivets which would normally be required to assemble the Curtiss P-40 belly cowl.



PHOTOGRAPHS COURTESY CURTISS-WRIGHT CORPORATION

Thanks to phenomenal advances in machines and techniques, aircraft manufacturers have replaced slow, costly riveting with speedy, economical spot welding. This is true not only of non-structural parts such as door and window frames, seats, engine and nacelle cowling—but also of primary stressed assemblies including floor supports, wing ribs and stabilizer leading edges.

Assembling the Curtiss Warhawk belly cowl, as shown in the photograph, is done on a magnetic impulse type of spot welder equipped with Mallory long-life electrodes. On many similar jobs, a template is laid down and markings made of pilot spots where the operator should weld. Use of spot welding saves man hours and machinery by the elimination of drilling and dimpling for flush riveting, two separate operations.

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	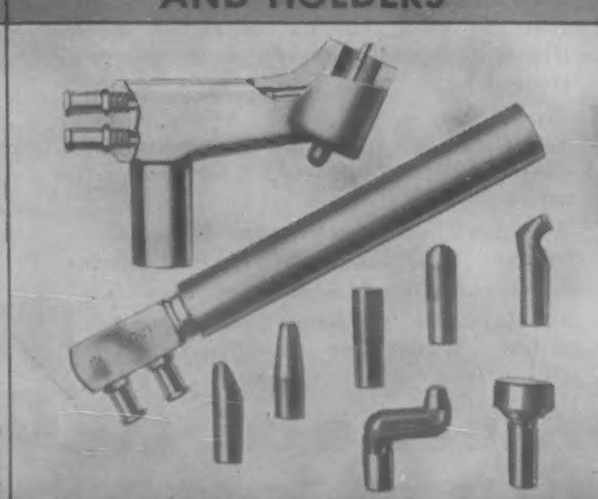	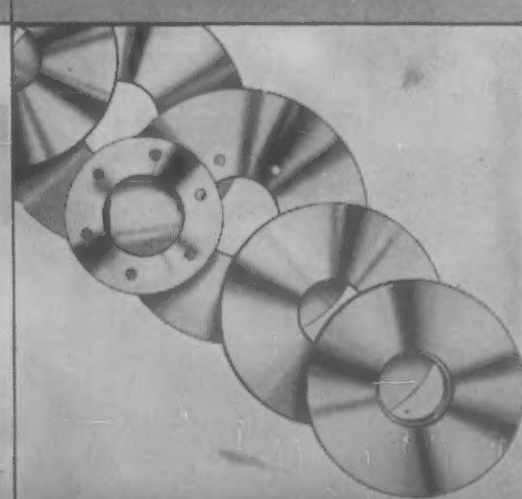

SPEEDIER PRODUCTION · LESS DOWN TIME · BETTER WELDING · LOWER COST

These joints are more economical with respect to weld metal and power than single-pass welds. In single pass work the mill scale must be removed from the adjoining surfaces on the bottom of the weld wherever the fluid metal penetrates. Otherwise the evolution of gases will cause porosity.

Welding Rod

There are three types of rod for welding plain carbon steels. Each has less than 0.20 per cent carbon. The first produces about 0.60 per cent and the second about 0.90 per cent manganese. They are appropriate for welding-plate ranges of 50,000 to 60,000 psi. The third type, like the second except that it produces about 0.3 per cent Mo, is used for ranges of 70,000 to 80,000 psi.

Two special types of austenitic rod have been developed for Unionmelt welding of armor plate. There are also special rods for welding corrosion-resisting alloys and rods for welding non-ferrous metals and alloys can be made available.

Grades of Unionmelt

There are three types of granular Unionmelt material and a type of highly refractory composition suitable for use as a backing-up material. The first type is suitable for a great range of plain carbon steel welding. The third is used where higher strengths are desired or with plate of poor quality. It preserves a higher proportion of manganese and keeps the silicon low. Therefore it is more suitable for multi-pass welding. The second type, like the third but having lower fluidity, is more suitable for circumferential seam welding.

Unionmelt material is prepared in four different mesh sizes. In general, fine granules produce a wider bead, less penetration and a smoother surface than coarse. With dirty steel, coarse granules give sounder welds. In choosing the mesh for different operations, the user should consult tables prepared for that purpose.

Welding Heads

There are three automatic heads, known as types M, U and S, for feeding the rod into the seam. Type M head will feed rod from ⅛ to ½ in. in diam., straightening and feeding ½-in. rod at the speed of 40 to 50 in. per min. Of heavy construction it is indispensable for heavy seam and chain welding.

The most useful is Type U which will feed rods from 1/16 in. to 5/16 in. in diam. It can be used in restricted spaces and in portable units for welding plates up to 1 in. in thickness. With double-vee preparation it will weld material up to 2¼ in. in thickness.

Type S, a smaller piece, can also be mounted on a portable carriage. It takes straight lengths of rod only. It is not suitable for high-speed repetitive work.

All of this equipment can be used for making plug welds at high speed. Under certain conditions a portable hand plug-welder is convenient. A hand-operated feeding mechanism for using long lengths of straight rod has been developed. It is believed it will be suitable for short

lengths of butt and fillet welds where currents up to 1200 and 1400 amp. may be used.

Handling Equipment

In most shipbuilding yards the welding head is mounted on a tractor unit. This propels itself on any flat surface and can be used for welding butt seams and fillet seams with up to about ⅜-in. leg. It may be operated on a truck or by a hand guiding device. For the repetitive welding of long straight seams as in railroad-car center sills, a gantry running on two trucks from which the welding head is suspended may be used. A newer installation has a head moving on its own carriage on a track supported in cantilever fashion from a steel building.

For pressure-vessel welding, the usual installation is a column based on a motor-driven carriage having a boom supported from it, cantilever fashion. The Type U-head is attached to the boom. With this both inside and outside seams may be welded. For wheel and drum welding and for special jobs, a fixed head may be attached to some simple mechanical movement. With it a manipulator or weld positioner is used.

—J. M. Keir, *Welding Journal*, Vol. 22, Mar. 1943, pp. 173-179.

Cold Drawing Welded Steel Tubing

Condensed from "Univ. Illinois Bulletin"

Cold-drawing of steel tubing is employed either to supply special sizes by drawing down from a larger standard size or to impart special mechanical properties to the tubing. In the process, the tubing is deformed beyond the yield point, strength and hardness are hereby increased and ductility decreased.

An exhaustive investigation was made for the purpose of evaluating the changes occurring in the more common mechanical properties of electrically welded S.A.E. 1010 steel tubing as a result of cold drawing the tubing in order to aid the manufacturer in producing tubing of known properties and to furnish information, for use in structural design, on the strength and ductility of low carbon welded and cold-drawn tubing.

The results can be summarized as follows: The suitable measure of the amount of cold working is the reduction of area, and is expressed as the percentage reduction of cross-sectional area of the metal in the tubing caused by the cold-drawing. The wall thickness remains approximately constant during cold drawing so that the reduction of area is roughly controlled by the change in outside diameter of the tubing.

Cold drawing of the S.A.E. 1010 steel tubing increases the tensile ultimate and yield strengths, the compressive maximum and yield strengths, and the Rockwell B hardness, but decreases the ductility of the tubing; the compressive maximum strength is defined as the maximum load per unit area that a specimen could resist before failure by local wrinkling.

The relations between these properties and the amount of cold drawing can be expressed, for cold-drawing of 10 per cent

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and more, by the formula $S = k\,Sa\,(1 + R)$ where S is the strength (tensile or compressive, ultimate or yield) k is a constant depending on material and type of test, Sa the same strengths as for S of the normalized tubing free from cold drawing, and R the reduction of area expressed as a decimal. The constant k has the value 1.27 for ultimate tensile strength, 1.33 for maximum compressive strength, 1.67 for tensile yield strength (0.20% offset), and 1.45 for compressive yield strength (0.20 per cent offset).

For amounts of cold drawing less than 10 per cent k should be taken from curves as the linear relation exists only about 10 per cent, but up to 10 per cent relatively large increases of strength and hardness are produced, *e.g.* 80 per cent increase in tensile yield strength by 10 per cent, and 150 per cent by 50 per cent of cold drawing.

A fairly definite relation was found for the cold-drawn S.A.E. 1010 tubing between ultimate tensile strength T and Rockwell B hardness number R_B, namely $T = \frac{4540}{146 - R_B}$. The tensile yield strength of the normalized tubing free from cold working was about 0.70 of the ultimate tensile strength while for cold-drawn tubing above 10 per cent reduction it was fairly constant at about 0.95.

The ductility of the S.A.E. 1010 steel tubing, as measured by the percentage elongation in an 8-in. gage length in the tension test, decreases rapidly with the amount of cold drawing up to about 10 per cent reduction in area, and decreases much less rapidly for further amounts of cold drawing. The decrease in ductility is about 70 per cent for 10 per cent cold drawing and about 90 per cent for 50 per cent cold drawing.

—W. E. Black, *Univ. Illinois Bull.* Vol. 40, No. 27, Feb. 23, 1943, pp. 1-32.

Fabrication of Pressure Vessels

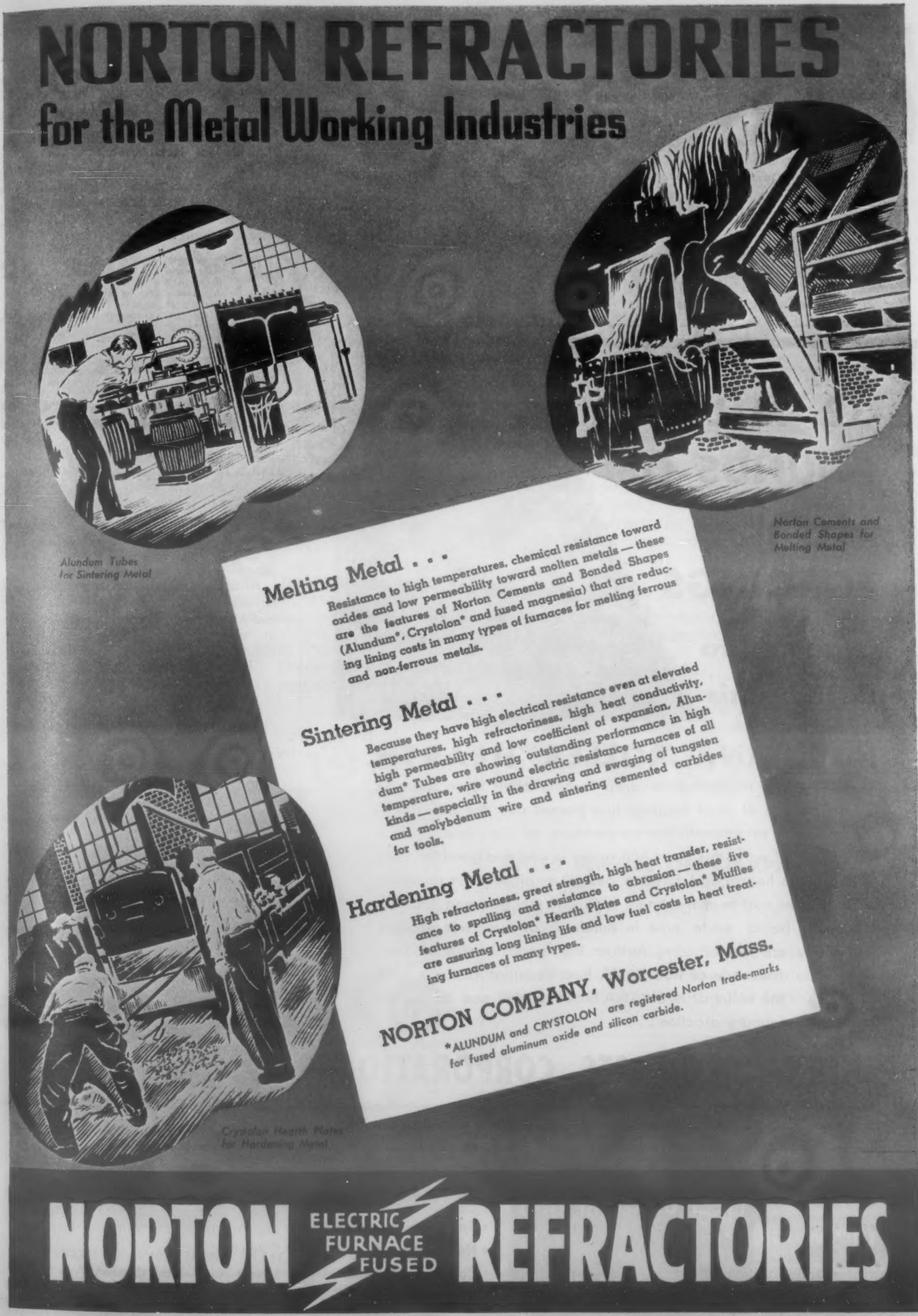
Condensed from "Engineering Inspection"

A mild steel with about 0.15 per cent C and 0.5 per cent Mn is very suitable for pressure vessels. Opinions differ as to the maximum silicon content but it is believed that it should be as low as possible to avoid premature killing of the weld deposit with ensuing brittleness. Recently low alloy and stainless steels have also been used. No matter what the type, the steel must be clean.

The electrode should be of a type which provides a reducing gas shield for the arc and a neutral slag over the weld deposit. Unionmelt automatic welding is being used considerably.

The first step in fabrication is the machining of the edges of the plate so that an almost parallel sided U is formed on assembly (except for Unionmelt). Then the plate is bent into a cylindrical shape. Test plates should be tack welded onto the end of the shell prior to welding so they will form a part of the longitudinal weld. Wherever possible, the work should be positioned so the operator is working in a down hand position.

After the longitudinal welds are made,



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Resistance to high temperatures, chemical resistance toward oxides and low permeability toward molten metals — these are the features of Norton Cements and Bonded Shapes (Alundum*, Crystolon* and fused magnesia) that are reducing lining costs in many types of furnaces for melting ferrous and non-ferrous metals.
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the circumferential seams are welded with the vessel rotating at the desired speed. When the welding is completed from the outside, the first run of metal is chipped out from the inside and two sealing runs deposited here. The welds are then dressed by chipping and grinding to leave a flush surface. Although this operation may remove the possibility of stress localization, it is done primarily to give more easily interpreted exographs.

Butt Welds

Simple butt welds are most generally used in pressure vessels, and fortunately, are the easiest to test by X-rays. Lead numbers should be attached to the vessel for identification as well as small gages known as penetrameter gages to prove that the technique is sufficient to show a defect equal to 2 per cent of the plate thickness. These gages increase in steps of 0.010 in.; so, in the case of a 1-in. plate, the 0.020 in. step should be clearly visible. The X-ray shows up mainly bad penetration, porosity, cracks, and slag inclusions.

Severe distortion is often erroneously considered indicative of severe stresses, although serious locked up stresses are more likely to occur in the absence of distortion. All boiler codes require a heat treatment of the vessel after welding to relieve stresses and to avail of the highest joint efficiency.

Two methods are worthy of consideration: Normalizing and sub-critical stress relieving. The first is less desirable because of the possibility of structural collapse at the high temperatures involved. The latter is more usual and is generally carried out by holding 1 hr. per in. of thickness at 620 deg. C. (1150 deg. F.) and cooling in still air.

Certain Test Requirements

The test plates which were welded at the same time as the longitudinal seams and heat treated with the vessel are cut into test specimens and must meet the following requirements:

1. Tensile properties—all weld metal specimen
   tensile strength not less than the minimum of the plate
   elongation—20% in 2 in.
   reduction of area—35%
2. Tensile strength across joint—not less than minimum of plate
3. Bend across weld—180 deg.
4. Izod impact
   notch in junction—30 ft. lb. min.
   notch in weld—30 ft. lb. min.
5. Satisfactory micro and macrographs

After all the operations required by the code have been performed, the vessel should be hydrostatically tested. The test pressure will be called for on the contract and is usually 1.5 $\times$ the working pressure + 50 lb. The vessel should be blanked up so as to permit examination of all parts during the test. Care should be taken to prevent sagging due to the weight of the water. Air pockets should be guarded against.

After the hydraulic test, the vessel should be drained, any silt or scale cleaned out and a final inspection of the interior made as well as a check of the alignment, circularity, and general dimensions.

—S. H. Griffiths, *Eng. Inspection*, Vol. 8, Spring 1943, pp. 4-24.

Blushing of Lacquers

Condensed from "Metal Finishing"

"Blushing" or "blooming" of a lacquer is the undesirable occurrence of a cloudiness or opacity in a clear film or a graying or iridescent loss of lustre on the surface of an enamel. Blushing will appear within a few minutes after the application of a lacquer and, if not severe, may disappear entirely when the film is dry. If sufficiently severe to persist in the dry film, it will not only detract from the appearance of the finish but may impair its physical properties.

Blushing indicates that one or more of the film forming ingredients in the lacquer has been precipitated out of solution while the film is still wet.

Inadequate distribution of hydrocarbon solvent in a lacquer may result in partial precipitation of the resinous components. This results in partial opacity of the film or in the presence of many microscopic gray specks. This condition is known as "gum blush." "Cotton blush" is a very similar condition and is caused by poor solvent balance. These two types of blushing are seldom encountered with modern materials. However, with increasing use of substitute materials as a result of wartime shortages, this difficulty may be encountered.

Solvent Blush—Most Common Type

The most common type of blush is known as "solvent blush," in which the

low temperature near the surface of the drying film causes condensation of water from a humid atmosphere. The water, not being miscible with the lacquer constituents, induces precipitation of the solid ingredients in the wet film. The extent of cooling of a lacquer film due to rapid solvent evaporation can be readily demonstrated if a thin metal panel is coated with lacquer or solvent and held in the hand while drying.

This type of blushing may be prevented either by altering the condition of the atmosphere or by lengthening the drying time of the lacquer, or both. Simply raising the room temperature will reduce the relative humidity and thus reduce the tendency for a lacquer to blush. However, this procedure may have the disadvantage of causing poor flow and excessive overspray by increasing the drying rate.

Another procedure is to reduce the absolute humidity of the air in the room by circulating it through condensers. This approaches actual air conditioning, which is the ideal solution although it is quite expensive.

Use of Retarders

A third method of controlling blushing consists in adding a "retarder" which lengthens the drying time of the lacquer. A retarder is a slow-evaporating solvent. The reduced evaporation rate of the lacquer-retarder mixture prevents the film from reaching the dew point. The dew point is the temperature at which moisture precipitates from the air.

Retarder solvents must be used with care since they increase the tendency for a lacquer to "run" and are expensive. More than 5 to 10 per cent by volume of retarder should not be required.

With a given lacquer, whether or not it will blush depends largely on the temperature of the air and the relative humidity. Relative humidity can be readily determined with a sling psychrometer. If a record of temperature, relative humidity, and blushing behavior is kept, sufficient data will soon be accumulated to predict whether a given combination of relative humidity and temperature will lead to blushing of a given lacquer. A convenient chart for representing these relations is given. Trial and error experience will soon show how much retarder should be used at given conditions.

Preventing Blushing

Certain obvious precautions should be taken to prevent blushing. For example drafts from open windows or shafts or a too-efficient exhaust system may invite blushing. An excess of moisture in the compressed air for spraying can contribute to blushing.

On lacquered work to be re-coated with a similar material a moderate amount of blush on the first coat is of no consequence if precautions are taken to avoid its recurrence on subsequent coats. A moderate blush can be dispelled by spraying the surface with a thinner of sufficient richness to redissolve the precipitate in the film and to prevent it from reforming.

—P. B. Torrance, *Metal Finishing*, Vol. 41, May 1943, pp. 314-316.

Nickel Plating Fine Wire

Condensed from "The Iron Age"

During the past decade European companies have been making incandescent lamp filament supports from fully annealed iron wire plated with nickel, in place of pure nickel supports. The coating must possess excellent adhesion and resistance to the volatilization of the iron core of the support.

Hanover Wire Cloth Co. produces this nickel plated wire with a saving of 95 to 98 per cent of nickel. After some experimental work a line was designed in which the wire is kept free from mechanical cold working or tension.

Wire is received in 8 in. diam. coils, which has been bright annealed. The cleaning portion consists of a soak cleaner, an electrolytic cleaner, and an electrolytic pickle with rinses after each operation.

Nickel plating is carried out in five separate cells, each one plating 1/5th the total thickness of nickel on the wire. Each cell is controlled by a tank rheostat. After plating, the wire is rinsed in cold water and then in boiling hot water. It is then put on spools.

The line has an average daily output of over 1,000,000 ft. of wire.

—James H. Conolly, *Iron Age*, Vol. 151, Apr. 1, 1943, pp. 50-51.

4 Materials and Engineering Design

Engineering Properties of Metals and Alloys • Resistance to Corrosion, Wear, Fatigue, Creep, etc. • Engineering Design Problems of Specific Industries and Products • Selection of Metals, Metal-Forms and Fabricating Methods • Non-Metallics in the Metal Industries • Applications of Individual Materials • Conservation and Substitution

CONTENTS

Plastic Bearings

Condensed from "Maschinenbau (Der Betrieb)"

Performance obtained with synthetic resin bearing materials, if material be correctly chosen and application suitable, will equal that of the best metal bearings. The plastic bearings require fundamentally different handling from that given metal bearings.

A special warning is given against relying upon a fixed and rigid load value such as the product of bearing pressure and rubbing speed, since their mutual effect differs from each range of load. The use of hardened and ground shaft journals, solid lubricating rings, and cooled journals improves load performances.

With small rubbing speeds, of the order of 0.1 meter per sec. (about 0.3 ft. per sec.), the specific bearing pressure must be reduced to prevent increased friction. Grease lubrication is required. With oscillating movement and grease lubrication, and 5 to 8 longitudinal grooves the whole length of the bearing surface, bearing pressures of 2800 to 3500 lbs. per sq. in. are permissible.

Impact loading reduces this amount, while intermittent operation permits its increase. With small rubbing speeds pressures to 1850 lbs. per sq. in. may be used if bearing temperature does not exceed 90 deg. C. Crane rotor or lifting shaft bearings are typical.

With a bearing designed in segments and held together by an outer frame, pressures of 7000 lbs. per sq. in. are permissible, as the frame supplies the strength which the plastic lacks. This type should be used for pressures above about 2000 lbs. per sq. in.

For light and medium pressures of about 3500 lbs. per sq. in. coarse shaving fillers in molded form can be used, while for high loads the stronger hard fabric type of filler is advised. As the heat conductivity of plastic materials is about 800 times less than copper the danger of overheating must be counteracted by proper design. Hard fabric materials may run continuously at 110 deg. C., or to 150 deg. C. for short periods.

Constant aging in oil or water results in absorption of only traces of fluid at the surface, with inconsequential swelling. Adherence of lubricant to bearing surface can reduce power losses by as much as 35 per cent.

The mean value of bearing wall thickness should be about 10 per cent of shaft diameter. Tolerances to insure satisfactory force fit between the outside of the bearing and inside of the housing are 5 times greater than with metal. Short bearings, having a length-to-diameter ratio of one or less, help to prevent heat accumulation. When longer bearings are necessary they may be divided into two halves.

The molding skin or film formed during manufacture at the bearing surface should be carefully removed by machining to insure adherence of the lubricant. Bearing clearance must be very much greater than for metal, to allow for the slight swelling caused by the lubricant. Careful running-in is necessary, with a 120 deg. to 130 deg. maximum temperature.

Special care must be taken with lubrication. Oils of pure animal or vegetable base are unsuited to plastic bearing lubrication. Refined mineral oils or special oils are best. About 80 to 100 per cent more cooling water will be required than for metal bearings.

Plastics can be machined easily with high speed or diamond tools, without cutting fluids.

—H. Frank, *Maschinenbau (Der Betrieb)*, Vol. 21, June, 1942, pp. 257-261; condensed in *Engineer's Digest*, Vol. 4, Mar. 1943, pp. 77-80.

Thermal Expansion of Metals

Condensed from "Journal of Research," Natl. Bur. of Standards

The results obtained in the course of independent tests and investigations on the linear expansion of four groups of bronzes designated as tin-zinc, leaded, aluminum, and silicon bronzes are given for different temperature ranges. In the tin-zinc group the tin ranges from 1 to 30 per cent and the zinc from 1 to 10 per cent. The leaded bronzes contain from 10 to 20 per cent Pb.

The aluminum bronzes are of the 10 per cent type and the silicon bronzes contain 3 to 4 per cent Si. Curves showing the typical expansion and contraction characteristics of these alloys are given for temperatures varying for the different types up to 1000 deg. C. (1832 deg. F.). Ternary diagrams are presented to show the effect of composition on the coefficients of expansion of copper-tin-zinc and copper-tin-lead alloys.

In general, the coefficients of expansion of these copper-base alloys increase as the addition of tin, zinc, or lead is increased. For the range from 20 to 100 deg. C. (68 to 212 deg. F.) the average coefficients of expansion of the various bronzes were found to be between 16.8 x 10^{-6} and 19.0 x 10^{-6} per deg. C.

The expansion of 97.2 per cent Ti is given at various temperatures between —190 and +700 deg. C. (—310 and +1292 deg. F.). The coefficient of expansion of titanium increases from about 5 x 10^{-6} per deg. C. at —150 deg C. (—238 deg. F.) to about 12 x 10^{-6} per deg. C. at +650 deg. C. (1202 deg. F.). The data on thermal expansion do not indicate the existance of polymorphic transformations of titanium between —190 deg. and +700 deg. C. (—310 and +1292 deg. F.).

—Peter Hidnert, *J. Res., Natl. Bur. Standards,* Vol. 30, Jan.-Feb. 1943, pp. 75-88, 101-105.

Heat-Treated Carbon Steel Bolts

Condensed from "Steel"

Using heat-treated bolts and cap screws saves steel, conserves critical alloying elements, cuts the weight of the fastening, reduces its cost, and improves its efficiency. It is most important that the smallest bolts that will carry the load safely be used.

Actual strength of bolts, particularly those of small diameter, is much higher than calculated values. The reason for this is the full hardness throughout the center developed by the quench as a result of "mass effect" and by the more rapid cooling effected by the threads.

Tests show that ultimate strengths of 150,000 to 170,000 lbs. per sq. in. can be attained in standard heat-treated carbon steel bolts and cap screws in sizes from 3/8 to 3/4 in. in diameter. This compares with 60,000 to 75,000 lbs. per sq. in. for ordinary hot-rolled steel bolts and capscrews not heat treated. A 1/2-in. heat-treated bolt can be used to replace a 3/4-in. bolt not heat treated since it has the same strength.

For the same length, a 1/2 bolt weighs about 40 per cent as much as a 3/4 in. bolt. Thus about 60 per cent steel is saved while doing the same job. Both steels cost about the same per pound. Such heat-treated bolts can be used to replace alloy steel bolts in many applications.

Use of a smaller diameter heat-treated bolt results in a better fastening being obtained because the full strength of the bolt can be developed much easier in tightening.

—A. E. R. Peterka, *Steel,* Vol. 112, May 10, 1943, pp. 86-88, 90, 135.

High-Silicon Steels

Condensed from "Stahl u. Eisen"

The objections against use of silicon in structural steels are critically examined by means of statistical evaluations of mechanical properties obtained in practical operations. The influences of silicon and manganese, and also carbon, copper and phosphorus on tensile strength, elastic limit and elongation in rolled condition are investigated.

The steel predominantly alloyed with silicon (the German silicon steel St '52) was found superior. The prejudices now held against silicon because of difficulties in welding are considered not to be justified. Brittle fractures occurring in welded structures are due not to composition but to the condition of the material.

It could be shown that by using commercial electrodes and steels with varying silicon contents, steels with 0.95 per cent silicon could be welded just as satisfactorily as a steel with 0.4 per cent silicon and 1.3 per cent manganese, which is well known for its weldability.

—W. Mantel, *Stahl u. Eisen*, Vol. 62, 1942, pp. 222-228.

New Lead Alloy for Coated Copper Conductors

Condensed from an American Society for Testing Materials Paper

Much of the wire used for electrical conductors in normal times was coated with pure tin to facilitate the soldering of joints and connections and to protect the underlying copper and its rubber insulation from reacting with each other. The shortage of tin, however, has impelled a search for materials that comply with the WPB order limiting the tin content of copper-conductor coatings to 12 per cent, and which will perform satisfactorily.

The requirements for such coatings are amenability to fast soldering, good resistance to abrasion, excellent anti-friction properties and resistance to corrosion by sulphur and by rubber chemicals of the coated wire is to be successfully and completely substituted in all the various types of twisting, stranding and cabling machinery and different models of insulating machines without retarding the war output.

Of all the possible substitutes tested by Anaconda Wire and Cable Co. (including lead-base alloys of less than 5 per cent tin), the only one that approached the desired properties was a newly developed alloy — essentially lead to which small amounts of cadmium, tin and antimony are added. Average analyses of coatings from the new alloy show 5.23 tin, 1.17 cadmium, 0.30 antimony and 93.30 per cent lead.

The alloy has been in continuous use for 16 months, during which time 500 million lbs. of wire has been coated, stranded and insulated with entirely satisfactory results. Statistical analysis of the substitution show that approximately 87 per cent of the tin previously consumed for this application is being saved by the use of the new alloy. At Anaconda this means a saving of about 3500 lbs. of tin per month.

—C. J. Snyder, Amer. Soc. Testing Materials, Preprint No. 33, June 1943 meeting, 9 pp.

German Stainless Steels

Condensed from "Metallwirtschaft"

The number of rust- and acid-resistant steels has increased, during the last 10 yrs., from 5-7 to 20-25 comprising (a) the austenitic chromium-nickel steels with titanium or columbium and with carbon below 0.07 per cent that are resistant against intergranular corrosion, (b) the nickel-free weldable ferritic chromium and chromium-molybdenum steels, (c) the hardenable chromium-molybdenum steels and (d) the austenitic-ferritic chromium-molybdenum and rust-resisting steels for automatic machine tools.

Recent experiments have shown that ex-

COPPER ALLOY BULLETIN

CAUSES OF CORROSION

INFLUENCE OF WATER COMPOSITION

In the last installment of this series the effect of the deposition of calcium carbonate on tube walls was discussed. For some purposes such depositions may be useful, for they will resist corrosion for generations. However, in water heating coils, boiler, and condenser tubes such a coating serves as an effective insulation which often results in "overheating" and "burning" failures.

The influence of the hydrogen ion (H^+), pH, has been studied in great detail and has been found to vary in its influence depending upon the metal being corroded and upon the concentration of all the other materials present. Generally an increase in the concentration of hydrogen ions accelerates the rate of corrosion of a metal.

The pH value is in a sense misleading since a low pH value indicates a high concentration of hydrogen ions and likewise a high pH value indicates a low concentration of hydrogen ions. This is understood better when it is remembered that mathematically expressed the pH is equal to the logarithm of the reciprocal of the hydrogen ion concentration in terms of gram equivalents per liter of solution, $pH = \log_{10} \frac{1}{[H^+]}$ or the negative logarithm of the hydrogen ion concentration $[H^+] = 10^{-pH}$. It is evident from the table below that the pH scale is much more convenient to use than Normality. For example if the activity is 10^{-n} normal the pH value of that solution is n, i.e. only the hydrogen exponent is used.

Pure water dissociates or breaks up to a very slight degree according to the equation $H_2O \rightleftarrows H^+ + OH^-$ so that it contains 1/10,000,000 of a gram equivalent of hydrogen ions per liter which is 1/100,000,000ths of 1% of hydrogen ion by weight! This also means that pure water containing 10^{-7} (pH 7.0) gram equivalents of hydrogen ions (H^+) must of necessity contain an equal quantity of hydroxide ions (OH^-). The product of these two quantities (the dissociation constant) is always the same $10^{-7} \times 10^{-7} = 10^{-14}$ at 25°C. Therefore if the concentration of hydrogen ions is 10^{-5}, the concentration of hydroxide ions must be 10^{-9}. The pH of 7.0 for pure water is also called the neutral point and water solutions with pH values below 7.0 have acidic properties and water solutions with pH values above 7.0 display basic properties. Exposure of pure distilled water to air, which contains approximately 0.04% carbon dioxide, lowers the pH to about 6.0 or lower. This represents a 10-fold increase in hydrogen ion concentration. Rain water has a pH of 6.0, acid swamp water a pH of 5.0, soda water (water charged with carbon dioxide gas) a pH of 3.8, and clean sea water a pH of 7.8.

RELATION BETWEEN HYDROGEN ION CONCENTRATIONS AND pH VALUES

	Concentration of Hydrogen Ions in Solution (Activity)	pH Value	Examples (25°C)	% by weight	Grams per liter
Increasing Acidity ↑	1.39 Normal*	—0.14	Hydrochloric Acid 2.0 Normal	7.1	72.94
	1.00 "	0.00	" " 1.2 "	4.3	43.70
	0.80 "	0.10	" " 1.0 "	3.6	36.47
	0.44 "	0.36	" " 0.5 "	1.8	18.22
	10^{-1} "	1.0	" " 0.12 "	0.44	4.37
	10^{-2} "	2.0	" " 0.01 "	0.036	0.364
	10^{-3} "	3.0	" " 0.001 "	0.0036	0.036
	10^{-4} "	4.0	" " 0.0001 "	0.00036	0.0036
	10^{-5} "	5.0	" " 0.00001 "	0.000036	0.00036
	10^{-6} "	6.0			
	10^{-7} "	7.0	Pure Water		
Increasing Basicity ↓	10^{-8} "	8.0			
	10^{-9} "	9.0	Sodium Hydroxide 0.00001 Normal	0.000040	0.00040
	10^{-10} "	10.0	" " 0.0001 "	0.00040	0.0040
	10^{-11} "	11.0	" " 0.001 "	0.0040	0.040
	10^{-12} "	12.0	" " 0.01 "	0.040	0.40
	10^{-13} "	13.0	" " 0.12 "	0.48	4.80
	$10^{-13.6}$ "	13.6	" " 0.5 "	2.0	20.00
	$10^{-13.9}$ "	13.9	" " 1.0 "	3.8	40.01
	$10^{-14.0}$ "	14.0	" " 1.2 "	4.6	48.00
	$10^{-14.1}$ "	14.1	" " 2.0 "	7.4	80.02

*Normal, i.e. gram equivalents per liter.

NEW DEVELOPMENTS

This column lists items manufactured or developed by many different sources. None of these items has been tested or is endorsed by the Bridgeport Brass Company. We will gladly refer readers to the manufacturer or other sources for further information.

Corrosion proofing of finished machinery, machine parts and instruments that are enclosed in sealed containers to protect them against moisture is said to be effected by the inclusion of silica gel in bags which have been developed for this purpose. The bag is made of breathing-type paper which permits the silica gel to absorb the moisture inside the package without dusting the contained material. **(No. 470)**

A newly developed line of steel bins for holding small work pieces within easy reach of an assembly job operator has been placed on the market. Each bin is fitted with a lip at the front to assist in picking up the parts. Five sizes, varying in width, are all 7¼ inches in length. Two styles are equipped with hoppers at the rear to provide a steady flow of the small parts. **(No. 471)**

Blue welders' glasses provide better vision for aluminum and bronze welding, glass working and similar operations where sodium yellow glare is present. This glass has been developed recently for reducing sodium yellow glare only. The standard green glass is still recommended for acetylene and electric arc welding. **(No. 472)**

A universal machine vise adaptable for mounting on any machine tool permits machining operations such as milling, drilling, grinding and boring at any angle. Complicated compound angles can be set up easily and quickly and the unit may be mounted to bed or table of the machine. The unit is portable and can be moved without disturbing the set angle or removing the work. **(No. 473)**

A pneumatic blow gun with pistol grip and trigger control has been designed for cleaning service in production plants. The gun is fitted with a removable nozzle that is interchangeable with longer units which can be inserted in deep holes and recesses. Connection is made through the handle with an adapter for a standard hose fitting. **(No. 474)**

A swivel head and flexible shaft for a portable drill has been placed on the market. A 30-inch flexible shaft with a ¼-inch core and an outside diameter of ⅝-inch serves to connect this new swivel drill head to a standard portable drill. The electric tool can be strapped to a belt worn by the worker and the swivel head grasped in one hand to do the drilling. **(No. 475)**

A hole punching unit has recently been offered with a built-in adjustable adapter which provides an adjustment up to 1½ inches front to back for off-center or staggered hole patterns. By designing the punch and die into the same independent holder it is possible to locate hole punching units in exact position by simply sliding the units along the rail or moving them from front to back on this new adapter and locking them in position. **(No. 476)**

efficient in sulfuric acid.

Caustic Solutions

No effective inhibitors of the attack of aluminum by strong caustic solutions are known. The inhibitive action of silicates and chromates in carbonate solutions is well known. Several fluophosphates and fluosilicates were also found to be effective inhibitors in sodium carbonate solutions but not in sodium hydroxide solutions. Triethonolamine and other alkaline organic compounds, normally corrosive to aluminum, can be inhibited with sodium silicate or chromate.

A large number of different chemicals were tested in different types of synthetic and natural tap waters and in dilute salt solutions. In most cases, silicates, chromates, and soluble oils were the most effective inhibitors. Colloids such as gelatin were effective under some conditions, but were dangerous in that they tended to localize the attack in cases where they were not completely effective.

Several tests were conducted to evaluate the effectiveness of various inhibitors for preventing galvanic corrosion caused by contact between aluminum and a dissimilar metal. Sodium chromate, while an effective inhibitor for uncoupled aluminum exposed to chloride solutions, was a "dangerous" inhibitor for preventing galvanic attack of aluminum, even in very dilute chloride solutions. (A dangerous inhibitor is one which causes localized attack or pitting).

Sodium disilicate effectively prevented galvanic attack of aluminum in solutions containing up to about 10 p.p.m. of sodium chloride, while Soluble Oil No. 1 was effective in solutions containing up to about 50 p.p.m. of sodium chloride. At higher sodium chloride concentrations, none of the inhibitors effectively prevented galvanic attack. In the above experiments, copper was the metal coupled with aluminum.

In another test, corrosion of aluminum by a natural well water was prevented by 1/4 oz. per gallon of sodium disilicate, sodium chromate, or strontium chromate. The well water had a pH of 4.1 and contained 14 p.p.m. of chlorides and 345 p.p.m. of total dissolved solids. When the aluminum was coupled to steel in this water, it was not possible to prevent corrosion of both the steel and the aluminum with sodium chromate.

Types of Inhibitors

Three types of chemicals have received considerable service use as corrosion inhibitors for aluminum. These are: (1) chromates and dichromates, (2) soluble oils, (3) soluble silicates.

Calcium chloride and sodium chloride brines inhibited by the addition of sodium or potassium chromate or dichromate have been widely used in contact with aluminum alloy piping and processing vessels. An installation is described in which no sign of corrosion was observed after 6 years use.

In another instance an ethyl alcohol-water solution, used as a coolant, caused pitting of an aluminum cooling jacket. After 2 years, pits having a maximum depth of 0.029 inch had developed. Subsequently, 1/8 oz./gal. of dichromate was maintained in the cooling liquid. After an additional 2 years service, old sections of the jacket previously pitted showed no further corrosion, while new sections showed no attack at all.

It should be emphasized, however, that there are limitations to the use of chromates. In general, they are not safe for use to prevent galvanic action between aluminum and other metals in waters high in chlorides and may be harmful instead of beneficial even in the absence of galvanic action, for boiling chloride solutions. Soluble oil inhibitors are somewhat safer for use under such conditions and have proven very satisfactory for preventing attack on aluminum automobile cylinder heads by waters and anti-freeze solutions.

Sodium silicates, having SiO_2 to Na_2O ratios of 2 to 1 or higher, are extensively used to prevent the action on aluminum of alkaline cleaners, or other materials having an alkaline reaction. In order to inhibit satisfactorily the action of hot sodium carbonate solutions on aluminum, about 22 per cent by weight of sodium disilicate ($Na_2O.2SiO_2$) must be added to the sodium carbonate. Similarly, about 30 per cent of the disilicate must be added to trisodium phosphate in order to inhibit the action of its hot solutions.

—R. B. Mears and G. G. Eldredge, *Trans. Electrochem. Soc.*, Preprint 83-16, Apr. 1943, 15 pp.

Testing, Inspection and Control

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CONTENTS

Wall Thickness of Castings

Condensed from "Engineering"

Direct-current methods of testing wall thickness have been applied to magnesium alloy breeches of airplane retractable undercarriages, and landing wheels using standard contact heads or modifications of head which retain the four-point principle. In this principle current from a d.c. source is passed through the metal wall by two contacts.

The potential drop caused by the current, which is a measure of wall thickness, is picked up by two closely adjacent contacts. (This method was described in *Proc. Inst. Mech. Engrs.*, Vol. 149, 1938.)

For the general run of castings the above method is recommended, but where very intricate castings are met it is difficult to get four contacts in confined spaces, such as spark-plug recesses and where the wall is often curved.

Intricate Castings

In testing intricate castings instead of applying the current locally, it is applied to two points and the potential drop picked up at the points to be measured by galvanometer or a triode type electrometer. Assuming the casting to be perfect, then the potential measured at any one point and position should be the same on all other castings of the same material. If, for example, with constant current, the potential instruments reading is 39 divisions on the perfect casting and at the same place on another casting, the reading is 50, it is certain that wall thickness is less than that design.

The flow pattern of the current in an intricate casting is so complicated, that it is only by reference to a number of castings with varying thicknesses that the actual wall thickness may be determined. However, once obtained, a "map" of potential readings versus thickness for all such castings may be used, and where number of castings have to be examined, it is well worth the trouble to obtain this initial calibration. Also, by means of a map, wall thickness limits of manufacture may be established.

In testing a six-cylinder cast iron truck engine, the first step was to obtain a map of the current flow, and from this a template was made, which locates the contact points at the same position and angle on each casting. Current of 10 amps. is passed through casting. Holes for the potential points are bushed with ferrules of an insulating material.

The casting is then drilled where potential points were applied and the results of wall thickness measurements marked on the drawings. At the ends of the castings the current is flowing in a three-dimensional path and different readings may be obtained from those found at places of the same wall thickness in the middle of the casting, but this should not cast doubt on the accuracy of the method.

A recent development in the manufacture of templates for locating the potential contact points is the use of a thermoplastic material (Perspex). A sheet of this material 1/8 in. to 3/16 in. thick is warmed to the plastic point. It is then placed on the casting and pressed. After the material is set, the template is removed. The same material can be used over and over again.

—B. M. Thornton, *Engineering*, Vol. 155, May 7, 1943, pp. 361-362.

Thickness of Tin Coatings

Condensed from "Sheet Metal Industries"

Accurate determination of the thickness of tin coatings has become more important as a result of the emphasis on tin conservation by the use of thinner coatings.

Clarke's method was originally designed for determining the thickness of tin coat-

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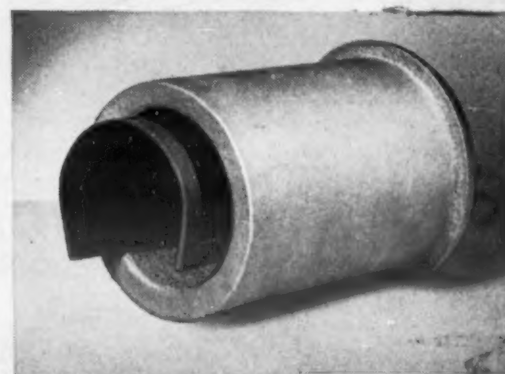

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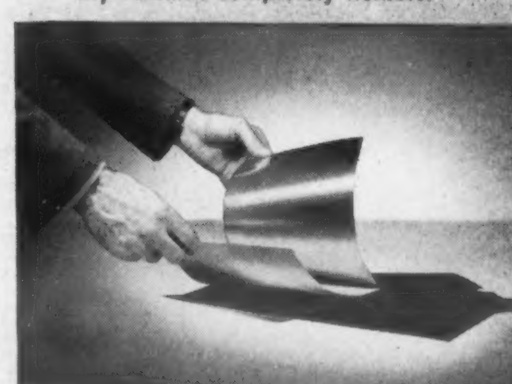

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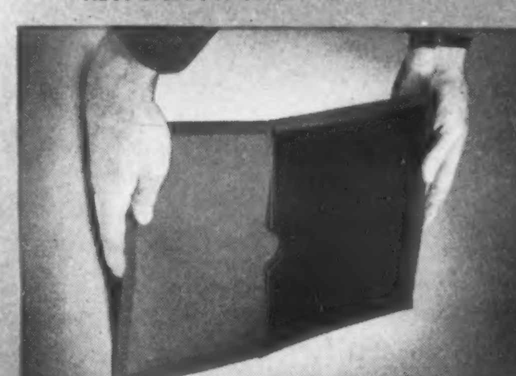

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ings on steel. Unless the tin coating is very thin, this method can also be used for brass and copper even though they are attacked by the solution. The specimens are degreased, cleaned and weighed. They are then immersed in a solution containing 20 grams of antimony trioxide in 1000 ml. cold hydrochloric acid (sp. gr. = 1.146).

One minute after gas evolution ceases, they are removed, washed immediately, dried and weighed. The difference in weight represents the weight of the tin coating. A certain amount of iron is dissolved as iron-tin alloy when hot dipped tin coatings are stripped; therefore 0.000004 in. (1 oz./basis box) should be deducted.

Cuprous Chloride: to determine the thickness of hot-dipped and electro-deposited tin coatings on copper. A solution is prepared by dissolving 12 grams of cuprous chloride in 40 ml. water plus 50 ml. concentrated hydrochloric acid. The cupric chloride which is almost certain to be present must be reduced either by adding a few pieces of scrap tinned copper or by heating with a few small pieces of copper foil. During the test a layer of paraffin is maintained on the surface of the solution to prevent oxidation of the cuprous chloride.

The degreased and weighed samples are immersed in the solution at a temperature of 90-100 deg. C. (195-212 deg. F.) for 10-15 minutes. The powdery deposit of copper is then brushed off, the specimen washed, dried and weighed. The difference in weight represents within about ±5 per cent the weight of the tin coating.

Sodium Plumbite: is used to determine the thickness of the free tin part of the coating (tin iron or tin copper alloy layers are unattacked). A solution is made up at 60 deg. C. (140 deg. F.) of 60 grams lead acetate, 100 grams caustic soda and 750 ml. water. The degreased and weighed specimen is immersed in the boiling solution for about 5 min. The exact time is found by plunging the specimen in cold water and examining to see if any bright patches of free tin remain; the time of immersion should not be unduly prolonged as there is a slight attack of the alloy layer. The specimen is finally washed, dried and re-weighed with the difference in weight representing the unalloyed tin.

Nitric-Hydrochloric Acid: to determine the approximate thickness of tin coatings on large steel articles. A solution of 5 volumes concentrated hydrochloric acid plus 1 volume concentrated nitric acid plus 15 volumes water is used at room temperature. About 30 min. is required to remove 0.001 in. of tin.

Dropping Test: can be applied to tin coatings on steel, brass and copper. Special apparatus is required. A solution of 100 grams trichloracetic acid and 1000 ml. water is dropped on the degreased sample at a rate of about 100 drops per min. The time is determined to remove the coating at the point of contact as determined by the appearance of the characteristic color of the basis metal. The equipment should be calibrated with coatings of known thickness, but 10 sec. is equal to about 0.0001 in. thickness of tin. Accuracy is ±15 per cent.

Iodine Titration: A specimen may be completely dissolved and the tin determined by the well known iodine titration volumetric method. This test is comparatively simple for tin coatings on steel, but if the basis metal is brass or copper these must be removed from solution by chemical separation methods before the tin is titrated.

Direct Weighing: Sometimes it is possible to weigh the components or test pieces before and after plating.

Various conversion tables are given for correlating thickness, weight of coating and weight per basis box (or base box). 0.0001 in. thickness = 0.00254 mm. thickness = 0.0119 grams/sq. in. or 1.72 grams/sq. ft. or 0.0606 oz./sq. ft. or 18.5 grams/sq. m. weight of coating on each face = 1 lb. 10.4 oz. per basis or base box.

In a discussion of this article, R. Johnston (May 1943, p. 879) suggests a new method: the degreased and weighed sample is immersed in a solution of about 5 per cent iodine in carbon disulphide for a few minutes. It is then washed, dried, and weighed. The results agree well with Clarke's method. The merit is said to lie in the very small iron loss.

—*Sheet Metal Industries*, Vol. 17, April 1943, pp. 625-627.

Manufacturers' Literature

YOURS FOR THE ASKING

1. Ferrous Metals

ALLOY STEELS

High Strength Steel. Alan Wood Steel Co. (1-1)

Manganese Steel. American Brake Shoe Co. (1-223)

Manganese Steel Chain. American Manganese Steel Div., American Brake Shoe Co. (1-186)

Steel Analysis Chart. American Steel & Wire Co. (1-218)

Low Alloy Steel. Bethlehem Steel Co. (1-117)

Alloy Steels. Peter A. Frasse & Co., Inc. (1-220)

High Strength Steel. Inland Steel Co. (1-90)

Molybdenum Wrought Steels. Molybdenum Corp. of America. (1-139)

Fatigue of Metals. Nitralloy Corp. (1-185)

Magnet Steels. Simonds Saw & Steel Co. (1-209)

Titanium in Steel. Titanium Alloy Mfg. Co. (1-201)

Vanadium. Vanadium Corp. of America. (1-180)

CARBON STEELS

Steel. Youngstown Sheet & Tube Co. Literature pieces describe the company's products, such as pipe, sheets, plates, conduits, bars, tin plate, etc. (1-227)

Cold-Finished Steels. Bliss & Laughlin, Inc. (1-206)

Warehouse Steel. Bernard Epps & Co. (1-216)

HIGH SPEED STEELS

High-Speed Steel. H. Boker & Co., Inc. This 6-page, pocket-size folder deals with "Novo Superior" steel (18-4-1). It lists recommendations for working in forging, annealing, hardening, drawing and machining. (1-226)

STAINLESS STEELS

Stainless Clad Steel ("Pluramelt"). Allegheny Ludlum Steel Corp. (1-161)

Stainless Clad Steel. Ingersoll Steel & Disc Div., Borg Warner Corp. (1-104)

TOOL AND DIE STEELS

Proper Tool Steel. Carpenter Steel Co. (1-219)

Tool Steels. Crucible Steel Co. of America. (1-193)

Air-Hardening Die Steel. Firth-Sterling Steel Co. (1-221)

Fast-Finishing Tool Steel. Jessop Steel Co. (1-132)

Tool Steel. Ziv Steel & Wire Co. (1-214)

IRON AND STEELS—GENERAL

Quality Machinery Steels. Horace T. Potts Co. (1-116)

2. Non-Ferrous Metals

COPPER AND ITS ALLOYS

Copper and Brass. Copper and Brass Research Assn. "Copper and Brass in the War" is a 36-page booklet giving a broad and variegated picture of this big subject. Illustrations play a prominent role. (2-226)

Copper and Its Alloys in Tubes and Plates. American Brass Co. (2-164)

Oxygen-free Copper. American Metal Co., Ltd. (2-145)

Tin-Less Bronzes. L. S. Cohen & Co., Inc. (2-221)

Forgeable Tin-free Bearing Metal. Mueller Brass Co. (2-165)

Phosphor Bronze. Phosphor Bronze Smelting Co. (2-100)

Phosphor Bronze, Etc. Riverside Metal Co. (2-223)

Leaded Bronze. Sumet Corp. (2-209)

LIGHT METALS

Alloys. Niagara Falls Smelting & Refining Corp. A 24-page booklet presents 20 years of history of the company. There are descriptions of the plant, the products and ultimate uses in munitions. (2-225)

Aluminum Fastenings. Whitehead Metal Products Co., Inc. A 72-page catalog enumerates completely items that the company has in stock, including rivets, machine screws and nuts, hexagon head bolts and nut washers. (2-224)

Magnesium Alloys. American Magnesium Corp. (2-57)

Magnesium Alloys. Dow Chemical Co. (2-104)

Magnesium. Fisher Furnace Co. (2-222)

Aircraft Aluminum Alloys. Reynolds Metals Co. (2-195)

LOW-MELTING METALS

Low Temperature Melting Alloys. Cerro de Pasco Copper Corp. (2-84)

Lead-Base Anti-Friction Alloy. Graphitized Alloys Corp. (2-183)

Babbitt Bearing Metals. Magnolia Metal Co. (2-191)

Lead. St. Joseph Lead Co. (2-188)

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Industrial Silver. American Platinum Works. (2-200)

SPECIAL METALS

Hard-Facing Metals. Coast Metals, Inc. (2-211)

Resistance Alloys. Wilbur B. Driver Co. (2-167)

Rare Metals, Alloys and Ores. Foote Mineral Co. (2-19)

Indium. Indium Corp. of America. (2-217)

Metal Powders. Powder Metals & Alloys, Inc. (2-149)

3. Engineering Design

ALLOY CASTINGS

Silicon Bronze Ingots for Castings. American Smelting & Refining Co., Federated Metals Div. (3-189)

Stainless Steel Castings. Atlas Foundry Co., Atlas Stainless Steel Castings Div. (3-266)

Heat Resisting Steel Castings. Chicago Steel Foundry Co. (3-263)

Alloy Steel Data Sheet. Cooper Alloy Foundry Co. (3-267)

Nickel-Chromium Alloy Castings. Driver-Harris Co. (3-69)

Alloys for Heat and Corrosion Resistance. Duraloy Co. (3-28)

Stainless Steel Pumps. Duriron Co., Inc. (3-132)

Nickel-Chromium Castings. Electro Alloys Co. (3-326)

Corrosion and Heat Resistant Castings. Michiana Products Corp. (3-91)

Cast Alloy Furnace Parts. Standard Alloy Co., Inc. (3-251)

Alloy Castings. Sterling Alloys, Inc. (3-261)

CASTINGS—IRON, STEEL, NON-FERROUS, ETC.

Non-Ferrous Castings. Howard Foundry Co. A 4-page bulletin covers production facilities of the three plants of this company. Weight comparisons and mechanical properties of magnesium are given. (3-333)

Meehanite Castings. Meehanite Research Institute of America. Higher resistance to shock and impact, and the importance of proper utilization of better tensile and compression strengths, are outlined in a 4-page folder. (3-321)

Centrifugally Cast Non-Ferrous Metals. Shenango-Penn Mold Co. An 8-page folder offers castings of bronzes, Monel metal and alloy irons. It is generously illustrated, with a center spread of specification tables. (3-339)

Bronzes. Ampco Metal, Inc. A 2-page literature piece, Nos. 112-113, describes this company's facilities and products. (3-332)

Heat Treated Aluminum Castings. Acme Pattern & Tool Co., Inc. (3-290)
Tool Shanks. Cooper-Bessemer Corp. (3-311)
Heavy-Duty Bronze Castings. Cramp Brass & Iron Foundries Div. (3-83)
Special Castings. Hamilton Foundry & Machine Co. (3-296)
Non-Ferrous Castings. Metal & Alloy Specialties Co. (3-298)
Non-Ferrous Castings. Thomas Paulson & Son, Inc. (3-268)
Centrifugal Castings. Shenango-Penn Mold Co. (3-250)

DIE CASTINGS

Electrical Contact Metals. Callite Tungsten Corp. Here is a 34-page modernistic bulletin on electrical contacts of silver, platinum, tungsten, molybdenum and a variety of other metals and alloys — their design, manufacture and application. (3-338)

Zinc Alloy Die Casting. New Jersey Zinc Co. (3-304)

FORGINGS

Drop Forgings. Drop Forging Assn. (3-237)
Special Forgings, Etc. Harrisburg Steel Corp. (3-292)
Drop, Hammer and Upset Forgings. Kropp Forge Co. (3-279)
Pressed and Forged Products. Lenape Hydraulic Pressing & Forging Co. (3-211)

METAL PARTS

Porous Bronze Bearings. Keystone Carbon Co. Lists contain pertinent information on Selflube bearings carried in stock and available for immediate delivery, an up-to-date list to be issued every 6 to 8 weeks. (3-331)

Spring Design. Mid-West Spring Mfg. Co. Here is a 40-page manual, with several novel features, on design and engineering, complete in formulas for compression, extension, torsion, flat spiral or motor, flat springs, wire forms, etc. It provides the executive, engineer, production man or purchasing agent with all needed information. (3-324)

Gilding Metal on Steel. Superior Steel Corp. Literature describes "Su Veneer," a steel clad with gilding metal which forms the jackets of millions of U. S. bullets. (3-341)

Pressed Metal Stampings. American Pulley Co. (3-297)

Bronze Bushings. Atlas Brass Foundry, Inc. (3-305)

Fittings for Weld-Type Construction. Bonney Forge & Tool Works. (3-199)

Blind Rivets. Cherry Rivet Co. (3-294)

Thermostat Metals. General Plate Div., Metals & Controls Corp. (3-181)

Electrical Contacts. Gibson Electric Co. (3-76)

Stamped, Drawn, Formed Parts. Goat Metal Stampings, Inc. (3-313)
General Purpose Bearings. Johnson Bronze Co. (3-245)
Sheet Metal Parts. Kirk & Blum Mfg. Co. (3-238)
Miniature Precision Bearings. Miniature Precision Bearings. (3-312)
Wear Resistant Precious Metal Parts. Permo Products Corp. (3-65)
Self-Lubricating Bearings. R. W. Rhoades Metaline Co. (3-46)

Metals and Alloys, 330 West 42nd St., New York, N. Y.

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NON-METALLICS

Wood. Kay Displays, Inc. A very old material is described in a most modern type of booklet, 24 pages. Though artistic presentation dominates, many practical facts, as to how wood can substitute for metals, are given. Seven case histories are presented. (3-334)
Non-Metallic Materials. Continental Diamond Fibre Co. (3-129)
Heat-Resistant Glass. Corning Glass Works. (3-319)
Plastics in Product Design. Durez Plastic & Chemicals, Inc. (3-93)
Plastic Data Book. Formica Insulation Co. (3-210)
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Glass. Libbey Glass Co. (3-299)
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Plastic Tubing and Fittings. Elmer E. Mills Corp. (3-247)
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Synthetic Rubber. United States Rubber Co. (3-316)
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Ceramic Plastics. Westinghouse Electric & Mfg. Co. (3-236)

POWDER METALLURGY

(See also Sec. 2—Special Metals; Sec. 3—Metal Parts; and Sec. 8—Metal Powder Processing)

Porous Bronze Bearings. Bound Brook Oil-Less Bearing Co. (3-310)
Powder Metallurgy Products. Powder Metallurgy, Inc. (3-89)

TUBING

Special Tubing. Summerill Tubing Co. "What's Cooking?" asks a single-page sheet of literature that shows an interior of the Summerill mill and tells a bit about the tubing. (3-337)

In this Manufacturers' Literature INDEX, new bulletins are given complete reviews, and previously described older bulletins are merely listed in their proper places.

Welded Steel Tubing. Formed Steel Tube Inst. (3-223)

Welded Steel Tubing. (price $1.00). Jackson Steel Tube Co., Inc. (3-282)

Special Tubing. Precitube Corp. (3-280)

History of Piping. Tube Turns, Inc. (3-303)

Pipe Protection Methods. Tubing Seal Cap, Inc. (3-272)

OTHER METAL FORMS

Zinc-Plated Steel. American Nickeloid Co. (3-330)

Pre-Plated Metal. Apollo Metal Works. (3-307)

Magnet Steels. Indiana Steel Products Co. (3-340)

Spinning Equipment. Milwaukee Metal Spinning Co. (3-315)

Steel Stampings. Worcester Pressed Steel Co. (3-273)

4. Melting • Refining • Casting

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Graphite Briquettes. U. S. Graphite Co. (4-112)

AUXILIARIES

Molding Sand Bonds. American Colloid Co. "News Letter," No. 4, is a single sheet describing Volclay Bentonite for use in the foundry. Common reasons for cracked castings are listed. (4-161)

Metal Reclamation. Hardinge Co. Bulletin No. 8-A is helpful to the foundry Diagrams of mills and reclamation plants explain how to salvage aluminum, magnesium, zinc and other wastes. (4-163)

Vibrators. New Haven Vibrator Co. General bulletin, "E," 1943, describes vibrators and accessories for various uses in the foundry. It is illustrated generously and is complete with price tables. (4-164)

Sprue Cutters. F. B. Shuster Co. This brief folder deals with cutters for the brass foundry for use in cutting castings from the gates. There is short text and specification tables. (4-165)

Centrifugal Casting Machines. Centrifugal Casting Machine Co. (4-154)
Graphite. Joseph Dixon Crucible Co. (4-152)
Drier for Sand Molds. Infra-Red Engineers, Inc. (4-155)
Aluminum Pattern Material. International Pulp Co. (4-150)
Foundry Equipment. Modern Equipment Co. (4-146)
Mold and Core Wash. Refractory Mica Products, Inc. (4-107)
Graphite Crucibles. Ross-Tacony Crucible Co. (4-159)
Foundry Core Oils. Swan-Finch Oil Corp. (4-157)
Universal Cut-Off Machine. Tabor Mfg. Co. (4-109)

REFINING AGENTS

Aluminum De-gasers. Foundry Services, Inc. This 6-page folder is a mailing piece that presents a brief message on the Foseco de-gaser. A detachable post-card invites further inquiry. (4-162)

Metal Purifiers. American-British Chemical Supplies, Inc. (4-156)
Calcium. Electro Metallurgical Co. (4-87)

Deoxidizers. *Pure Chemical Co.* (4-132)

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Cutting Crucible Costs. Crucible Manufacturers' Assn. (4-36)
Crucible for Non-Ferrous Melting. Electro Refractories & Alloys Corp. (4-96)
Recuperative Open Hearth Furnaces. Fitch Recuperator Co. (4-101)
Melting Furnaces. Harvey Furnace Co. (4-133)
Crucible Furnaces. Stroman Furnace & Engineering Co. (4-149)
Side Blow Converters. Whiting Corp. (4-153)

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Silvery Pig Iron. Jackson Iron & Steel Co. (4-126)

5. Heating • Heat Treatment

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SO_2 in Magnesium Industry. Ansul Chemical Co. (5-379)
Anhydrous Ammonia. Armour Ammonia Works. (5-435)
Pure Carbon Monoxide. Girdler Corp., Gas Processes Div. (5-386)
Control of Furnace Atmosphere. C. I. Hayes, Inc. (5-33)

AUXILIARIES

Quenching Tanks. American Gas Furnace Co. Bulletin No. 821 is one of a series of single sheets, this one describing the continuous automatic tank No. 15 with photos, diagrams and text. (5-443)

Furnace Controls. Automatic Temperature Control Co., Inc. A 12-page bulletin gives much technical information about the company's electrical equipment for fuel-fired furnaces, using diagrams and specification tables copiously. (5-445)

Infra-Red Drying. Gifford-Wood Co. Radiant energy for drying and baking are dealt with in an 8-page booklet, with photographs showing the various steps taken in the plant using it. (5-442)

Dry-Ice Cabinet. American Instrument Co. (5-391)
Heat-Transfer Equipment. Bell & Gossett Co. (5-319)
Infra-Red Burners. Burdett Mfg. Co. (5-427)
High Temperature Heating Elements. Carborundum Co., Globar Div. (5-122)
Pressed Steel Pots. Eclipse Fuel Engineering Co. (5-352)
Furnace Trays. Fahralloy Co (5-407)
Atmosphere Indicator. Claud S. Gordon Co. (5-437)
Cold Temperature Processing. Kold-Hold Mfg. Co. (5-406)
Oil Burners. National Aircoil Burner Co., Inc. (5-436)
Heat Exchanger for Metallurgical Operations. Niagara Blower Co. (5-293)
Sub-zero Chest. Revco, Inc. (5-350)
Furnace Door Hoists. Fred J. Ryan Co. (5-333)
Carburizer Screening Machine. Thurner Engineering Co. (5-419)
Infra-Red Lamps. Wabash Photolamp Corp. (5-404)

BATHS AND COMPOUNDS

Balanced Carburizing Baths. American Cyanamid & Chemical Corp. (5-135)
Carburizers, Salts, Quenching Oils, Drawing Compounds, Etc. E. F. Houghton & Co. (5-380)

BURNERS

Burners. Bloom Engineering Co. A series of single sheet bulletins are assembled under one cover, describing the Bloom long flame burners, as well as emulsion type oil burners, nozzle mix burners, etc. (5-439)

Infra-Red Ray Burner. Carbomatic Corp. (5-398)

Controlled Luminous Flame for Billet Heating Furnaces. Morgan Construction Co. (5-147)

ELECTRICAL HARDENING AND HEATING

Electric Forging Heaters. American Car & Foundry Co. (5-23)

Industrial Electric Heating. General Electric Co. (5-301)

Induction Heating Equipment. Induction Heating Corp. (5-226)

High Frequency Converters. Lepel High Frequency Laboratories, Inc. (5-124)

Induction Heating Furnaces. Robinson Induction Co. (5-387)

FURNACES

Small Work Furnaces. Mahr Mfg. Co. Bulletin No. 260, 2 pages, describes these furnaces in 8 sizes for tool and die shops, research laboratories, etc. It deals with construction, firing, door and controls. (5-444)

Gas Carburizing Furnaces. Surface Combustion Div., General Properties Co., Inc. Batch-type furnaces are dealt with in a 4-page folder, illustrated with photographs and graphs. (5-431)

Carburizing Gears. Ajax Electric Co., Inc. (5-399)

Electric Pot Furnaces. American Electric Furnace Co. (5-97)

Furnaces and Furnace Equipment. Amsler-Morton Co., Inc. (5-256)

Blowerless Furnaces. Baker & Co., Inc. (5-168)

High-Speed Steel Furnace. Bennett Insured Steel Treating Co. (5-310)

Industrial Furnaces. Chicago Flexible Shaft Co. (5-159)

Controlled Atmosphere Furnaces. Delaware Tool Steel Corp. (5-430)

Industrial Furnaces. Dempsey Industrial Furnace Co. (5-365)

Heat Treating Furnaces. Drever Co. (5-258)

Bright Annealing. Electric Furnace Co. (5-44)

Pot Furnaces. A. F. Holden Co. (5-409)

Gas Equipment. Charles A. Hones, Inc. (5-426)

Heat Treating and Laboratory Furnaces. K. H. Huppert. (5-303)

Industrial Gas Furnaces. Johnson Gas Appliance Co. (5-189)

Heat Treating Furnaces. Lindberg Engineering Co. (5-369)

Bright Gas Carburizing. Lithium Corp. (5-211)

Annealing Machines. Morrison Engineering Corp. (5-372)

Heat Treating Furnaces for Defense. R-S Products Corp. (5-244)

Electric and Fuel Car-Type Furnaces. W. S. Rockwell Co. (5-298)

Gas-Fired Oven Furnaces. Rolnick Testing & Mfg. Co. (5-175)

Heat Treating Furnaces. Salem Engineering Co. (5-341)

Bright Annealing Metal Strip. Sargeant & Wilbur. (5-200)

Clean Hardening for High-Speed Tools. Sentry Co. (5-202)

Tool Room Furnace. Harold E. Trent Co. (5-424)

Electric Salt Bath Furnaces. Upton Electric Furnace Div., Commerce Pattern Foundry & Machine Co. (5-295)

Induction Heating Units. Van Norman Machine Tool Co. (5-396)

Heat Treating Furnaces. Vulcan Corp. (5-368)

OVENS

Indirect Air Heaters. Despatch Oven Co. (5-338)

Near Infra-Red Process. Fostoria Pressed Steel Corp. (5-251)

Convection-Heated Ovens. Industrial Oven Engineering Co. (5-429)

PROCESSES

Surface Hardening Stainless Steel. Industrial Steels, Inc. (5-422)

6. Refractories • Insulation

Furnace Wall Coatings. Armor-Clad Co. A refractory for use in laboratories, metallurgical plants, industrial plants and on the high seas is treated in an 8-page, illustrated booklet, where word messages are briefly given. (6-126)

High Temperature Mortar. Ironton Fire Brick Co. Ironton "Alset" mortar for boiler settings, forging furnaces, steel mill furnaces, annealing ovens, etc. is presented in a 4-page folder. (6-128)

Refractories and Insulations. Refractory & Insulation Corp. Bonding cements, castable cements, ramming materials, as well as blanket, black, plastic and loose fill insulation are described in a 4-page folder, closely packed with reading. (6-127)

Heat Insulation. Baldwin-Hill Co. (6-99)

Basic Refractories. Basic Refractories, Inc. (6-59)

Plastic Super-Cement. Botfield Refractories Co. (6-94)

Refractory Coating Material. Brickseal Refractory Co. (6-67)

Masonry Saw. Clipper Mfg. Co. (6-82)

Flux Resistant Refractory. Corhart Refractories Co. (6-95)

Coating for Firebrick. Federal Refractories Corp. (6-118)

Refractories Maintenance Coating. A. P. Green Firebrick Co. (6-70)

Pocket Cost Calculator for Refractories and Insulation. Illinois Clay Products Co. (6-57)

Asbestos and Magnesia Products. Keasbey & Mattison Co. (6-113)

High Temperature Cement. Laclede-Christy Clay Products Co. (6-92)

Hiloset, a Mortar. Mexico Refractories Co. (6-83)

Super-Refractories Products. Mullite Refractories Co. (6-75)

Brick Linings. Plibrico Jointless Firebrick Co. (6-124)

Insulating Refractory Concrete. Quigley Co., Inc. (6-18)

Super Refractories. Charles Taylor Sons Co. (6-16)

Silica Tubing and Rod. Thermal Syndicate, Ltd. (6-103)

Fire Brick. Walsh Refractories Corp. (6-123)

7. Welding

BRAZING AND SOLDERING

Silver Flux. Scaife Co. Scaiflux 21, a flux for silver alloy brazing, is described in a 2-page sheet, giving general information and presenting four typical case histories. (7-224)

Solders. Alpha Metal & Rolling Mills, Inc. (7-184)

Welding, Brazing Aluminum. Aluminum Co. of America. (7-192)

Flux for Low Temperature Brazing. Handy & Harman. (7-119)

Solder for Aluminum and Its Alloys. Metalloy Products Co. (7-125)

Silver Brazing Alloy. Sherman & Co. (7-176)

Soldering, Brazing Flux. Special Chemicals Corp. (7-67)

ELECTRIC ARC WELDING

Welding Electrodes. Air Reduction Co. A comparative index of electrodes in tabular form is given in a 4-page folder. It details the principal AWS and ASTM classifications, and includes the products of 20 leading manufacturers. (7-215)

Welded Gun Carriages. James F. Lincoln Arc Welding Foundation. "Redesigned 40-mm. Anti-Aircraft Gun Carriages" is the title of a reprint, 11 pages, from an article in the "Welding Journal," by Dr. John L. Miller. (7-219)

Welded Bases for Machines. Lincoln Electric Co. A streamlined welded steel base for small machines is described in a 4-page folder, with copious diagrams to augment the text. (7-225)

A-C Welders. Allis-Chalmers Mfg. Co. (7-214)

Arc Welding. Ergolyte Mfg. Co. (7-213)

Arc Welder for Thin-Gage Metals. General Electric Co. (7-113)

Arc Welding Equipment Design. Harnischfeger Corp. (7-183)

Arc Welders. Hercules Electric & Mfg Co., Inc. (7-161)

Stainless Electrodes. McKay Co. (7-174)

FLAME-PROCESSING

Burning. National Cylinder Gas Co. Close tolerance shape cutting with the National Type J cutting machine is described in a 6-page folder. There are several illustrations of the machine in action. (7-227)

GAS WELDING

Low Temperature Welding Alloys. Eutectic Welding Alloys Co. A welding chart gives many details in tabular form, such as metals on which to use, physical properties, color match, corrosion resistance, procedure information, etc. (7-223)

Oxy-Acetylene Welding. International Acetylene Assn. A 20-page bulletin, entitled "Handbook for the Welding and Cutting Operator," is interestingly presented in a question-and-answer form. (7-212)

Charts for Welders. Victor Equipment Co. Two handy pocket-size charts present in tabulated form such items on cutting and welding as metal thickness, tip and drill sizes, oxygen pressure, consumption, gas pressure, acetylene cu. ft. per min., etc. (7-222)

RESISTANCE WELDING

Resistance Welder Control. General Electric Co. (7-150)

Spot and Seam Welders. Sciaky Bros. (7-163)

SUPPLIES

Welding Positioners. Bentley Weldery, Inc. (7-217)

Welding Positioner. Cullen-Friestedt Co. (7-68)

Fluxes. Krembs & Co. (7-221)

Welding Positioners. Lyon-Raymond Corp. (7-216)

THERMIT WELDING

Explosive Rivets. E. I. du Pont de Nemours & Co., Inc., Electrochemicals Dept. (7-205)

8. Metal-Working

FORMING

Colloidal Graphite. Acheson Colloids Corp. A single sheet deals with the treatment with "dag" colloidal graphite of piercer's tools and dies used in metal-forming operations. (8-286)

Aircraft, Etc. Dies. Algoma Products. Template dies, made from templates furnished by the customer, are described in a 4-page folder, one page being devoted to text and the rest to illustration. (8-291)

Hydraulic Presses. Anderson Bros. Mfg. Co. A single page deals with the HP-010 hydraulic hand press of 20,000-lb. capacity, containing text, photographs and specification tables. (8-279)

Dies for Drawing Wire, Etc. Carboloy Co., Inc. A cemented carbide die manual and catalog, 32 pages, is announced, covering standard and special dies for drawing wire, bar, tubing and sheet metal. Included are detailed recommendations on die shapes and die room accessories. (8-280)

Self-Contained Hydraulic Presses. Baldwin-Southwark Div. (8-65)

Hydraulic Press. Hydraulic Press Mfg. Co. (8-140)

Metal Extrusion Press. Hydropress, Inc. (8-210)

Extrusion Presses, Etc. John Robertson Co., Inc. (8-268)

Extrusion Presses. Schloemann Engineering Corp. (8-306)

Turret Punch Presses. Wiedemann Machine Co. (8-213)

FORGING

Helve, Etc. Hammers. C. C. Bradley Co. There are several single sheet pieces with photos, text, specification tables and prices. (8-305)

MACHINING

Cut-off Tools. Catskill Metal Works, Inc. A 2-page sheet presents the abrasive tool for tool steel, cold rolled steel, high-speed steel, cast iron, etc. (8-303)

Please Use the Coupon on page 397

Machine Tool Control. Detroit Universal Duplicator Co. This 16-page, 3-color broadside shows how the "Duplimatic" provides full automatic control to put intricate milling, turning, etc. operations on a high-speed production basis. (8-298)

Finishing Machines. Hammond Machinery Builders. A 6-page folder describes O.D. cylindrical grinding, polishing and buffing machines, illustrations depicting both the machines and the finished product. (8-296)

Shell-Making Tools. Hepburn American Co. Single-purpose machine tools for the manufacture of 2 to 12 in. shells, with many illustrations, are portrayed in a 26-page booklet. (8-281)

Cemented Carbides. McKenna Metals Co. A descriptive catalog is concerned with milling metals with cemented carbides, and is entitled: "Specialized Milling with Grayson-Kennametal Milling Cutters." (8-301)

Power Tools and Welding Equipment. Montgomery Ward & Co., Inc. This is a 50-page catalog of a prominent mail order house, showing many tools for the home or other small shop, well illustrated and tersely described. (8-284)

Hand Stoned Cutting Tools. Behr-Manning Div., Norton Co. An interesting 12-page booklet presents an argument for giving a final edge to milling cutters with oil-stones. (8-295)

Purifying Cutting Oil. Sharples Corp. This 12-page booklet, artistically presented, tells why purification is necessary and then explains how the "Super Centrifuge" works. (8-297)

Punching and Notching Equipment. Wales-Strippit Corp. After 2 pages of general information, this 8-page booklet is devoted largely to photographs and brief text. (8-300)

Milling Attachments. Fray Machine Tool Co. (8-267)

Dressing of Abrasive Wheels. J. & S. Tool Co. (8-270)

Planetary Milling. Plan-O-Mill Corp. (8-266)

Cutting Oils and Industrial Lubricants. D. A. Stuart Oil Co., Ltd. (8-91)

Cutting Fluids. Tide Water Associated Oil Co. (8-274)

Filters for Lubricants. U. S. Hoffman Machinery Corp., Filtration Div. (8-125)

Metal-Cutting Bandsaw. Universal Vise & Tool Co. (8-283)

Carbide Tool Grinders. Willey's Carbide Tool Co. (8-289)

ROLLING

Fine Wire Flattening Mill. McWilliams Mfg. Co., Inc. (8-250)

Turks Head. Standard Machinery Co. (8-192)

METAL POWDER PROCESSING

Presses for Powdered Metals. Kux Machine Co. (8-62)

Batch Mixers. Lancaster Iron Works, Inc. (8-129)

Metal-Powder Mixers. Patterson Foundry & Machine Co. (8-114)

Powder Metallurgy Presses, Molds. F. J. Stokes Machine Co. (8-54)

RIVETTING

Blind Rivets. B. F. Goodrich Co. The "Rivnut," an internally threaded and counterbored tubular rivet that can be headed blind, is described in a 12-page artistic pamphlet, abounding in diagrams and specification tables. (8-302)

9. Cleaning • Finishing

CLEANING

Vapor Cleaner. Circo Products Co. This 4-page folder describes the Dee Tee vapor cleaner for internal degreasing and drying, designed originally for cleaning and thawing differentials, etc. of automobiles. (9-296)

Electro-Cleaning. MacDermid, Inc. "Anodex," a reverse current process of cleaning prior to finishing or plating is described in a 4-page folder, temperately illustrated. (9-293)

Acid Rust Solvent. Nielco Laboratories. Two data sheets describe No. 1923, a metal cleaner for ferrous metals and galvanized sheets. (9-290)

Steam-Detergent Cleaning. Oakite Products, Inc. A 24-page pocket booklet tells how this cleaning method is used in metal-working and other industries. There are plenty of action pictures, and a wide variety of uses is outlined. (9-304)

Sodium Silicate. Philadelphia Quartz Co. Two pages are devoted to promoting sodium silicate for use in the metal industry and elsewhere, this being designated Vol. 23, No. 7. (9-291)

Blast Cleaning. Ruemelin Mfg. Co. This 8-page bulletin has much condensed information about blast cleaning cabinets, with numerous photos and specification tables. (9-271)

Degreasers and Cleaners. Colonial Alloys Co., Technical Processes Div. (9-286)

Airless Blast Cleaning. Dreisbach Engineering Corp. (9-229)

Metal Washing Machines. Howard Engineering & Mfg. Co. (9-305)

Dust Collecting Equipment. Industrial Equipment Corp. (9-184)

Metal Cleaning. Magnus Chemical Co. (9-282)

Cleaning Compounds. Magnuson Products Corp. (9-254)

Metal Washing Machines. Metalwash Machinery Co., Inc. (9-306)

Heavy Duty Cleaning of Ferrous Metals. Pennsylvania Salt Mfg. Co. (9-129)

Cleaning Equipment for Metals. N. Ransohoff, Inc. (9-230)

Processing Carriers. Rolock, Inc. (9-214)

Metal Cleaner. Turco Products, Inc. (9-198)

Abrasive Cleaning. Vapor Blast Mfg. Co. (9-166)

CHEMICAL TREATMENTS

Deoxidizing Steel Shell Cases. American Chemical Paint Co. A 4-page folder and two data sheet inserts describe "Deoxidine No. 170" for preparing shell cases for varnish and paint finishes. (9-298)

Anodizing Aluminum. Mutual Chemical Co. of America. Performing this with the chromic acid process is the subject of a 22-page booklet, with text, tables, graphs and diagrams. A list of the company's products is in the back. (9-302)

Black Oxide Finish. Puritan Mfg. Co. A 4-page vest-pocket folder deals with "Pur-Blac" for iron and steel surfaces, all text, no illustrations. (9-307)

ELECTROPLATING

Electroplating. W. Green Electric Co. A 4-page folder describes the Multi-Plater, consisting of text, a photo and a page of diagrams. (9-300)

Chromium Plating. Industrial Chromium Corp. A 4-page folder, designed for loose-leaf binding, Unit No. 100, gives miscellaneous news and facts concerning the company and plating. (9-303)

Copper Plating. United Chromium, Inc. The Unichrome copper plating process is described in a 6-page, novel, pocket-size folder, affording 7 minutes of reading. (9-301)

Anodizing Aluminum Rivets. Burrell Technical Supply Co. (9-285)

Black Finish for Steel. Du-Lite Chemical Corp. (9-244)

Oxide Finish for Steel. Empire Solvents Corp. (9-281)

Blackening Aluminum. Enthone Co. (9-278)

Black Steel Finish. Heatbath Corp. (9-185)

Chemicals for Protecting and Coloring Metal Surfaces. Mitchell - Bradford Chemical Co. (9-152)

METALLIC COATINGS (Non-Electrolytic)

Lead Base Coatings. Carbozite Corp. A 6-page folder describes several Carbozite coatings, including "Metalead" for spray application and for use around acids and other corrosive chemicals. (9-292)

Lead Plating. Harshaw Chemical Co. The chief topics of this 8-page bulletin are suggested uses, solution preparation, equipment and procedure, and analyzing the solution. (9-294)

Preparation for Metallizing. Metallizing Engineering Co., Inc. (9-239)

NON-METALLIC AND ORGANIC COATINGS

Corrosion Resistants. Corrosion Control Corp. A 4-page folder describes a "plastic suspended in a hydro carbon vehicle." It lists some of the armed service departments that use the material, "Co-Res-Co." (9-280)

Protective Coatings. Hilo Varnish Corp. U. S. Government specification coatings have been compiled in 60 mimeographed typewritten pages. It pertains to enamels, lacquers, varnishes, etc. (9-295)

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Rustproof Finishes. Truscon Laboratories, Inc. Quick-drying Truscon finishes used on machinery and metal articles are referred to in Vol. 2, No. 12 of "Building Maintenance." (9-299)

Coatings. Chicago Vitreous Enamel Product Co. (9-283)

Rust-Inhibiting Wax Coatings. S. C. Johnson & Son, Inc. (9-234)

Heat Resistant Coatings for Steel. M. W. Kellogg Co. (9-236)

High Temperature Coatings. George R. Mowat Co. (9-272)

Infra-Red Coating Standards. Stewart Research Laboratory. (9-275)

PICKLING

Pickling Agent. Monsanto Chemical Co., Merrimac Div. (9-63)

POLISHING

Polishing Machine. Divine Brothers Co. A 2-page sheet describes two abrasive belt polishing machines, with photos, brief text and specification tables. (9-297)

10. Testing · Control

CONTROL INSTRUMENTS

Tachometers. James G. Biddle Co. The Jones heavy-duty hand tachometer is portrayed in a 4-page folder, an instrument that indicates r.p.m. for many moving parts. (10-404)

Pyrometers and Salt Baths. Brown Instrument Co. A six-page photo-offset booklet portrays pyrometer control of high-speed salt baths, claiming that radiamatic and sillimanite target tubes solve problems of couple protection. (10-399)

Tank Controllers. Plating Processes Corp. An 8-page pocket-size folder describes an electronic tank controller, which keeps tanks at proper level at all times, insuring correct operating conditions. (10-400)

Cooling Controls. Sarco Co., Inc. A 12-page bulletin, No. 700, covers self-operated temperature regulators and mixing valves. It is completely illustrated, and includes many typical hook-ups and capacity tables, prices, etc. (10-398)

Temperature Control Instruments. Wheelco Instruments Co. Bulletin No. Z6200 is a condensed catalog, giving prices and short descriptions of all Wheelco instruments. It also refers to specific bulletins covering particular instruments. (10-392)

Furnace Controls. Bristol Co. (10-346)

Heat Controls. Burling Instrument Co. (10-378)

Thermostatic Bimetal. W. M. Chace Co. (10-387)

Control Devices for Atmosphere Furnaces. Fischer & Porter Co. (10-373)

Rheostats. Ohmite Mfg. Co. (10-335)

Thermocouples, Etc. Arklay S. Richards Co., Inc. (10-355)

Indicating and Recording Controllers. C. J. Tagliabue Mfg. Co. (10-379)

HARDNESS TESTING

Micro Hardness Testers. Eberbach & Son Co. A 10-page booklet portrays an instrument to measure hardness of micro constituents of metallic alloys. Several pages are devoted to directions for using this tester. (10-393)

Hardness Testers. Riehle Testing Machine Div., Am. Machine & Metals, Inc. A single sheet, one of a series, describes the hydraulic Brinell hardness tester, with a photo, diagram, text and specifications. (10-407)

Portable Brinell Hardness Tester. Andrew King. (10-148)

INSPECTION DEVICES

Angle Computer. Angle Computer Co. These computers for lay-out of die work, survey of castings and inspection of precision-machined parts are described in a 6-page folder, profusely illustrated and pleasing to the eye. (10-396)

Scales. Detecto-Gram Scales Div., Detecto Scales, Inc. A single sheet describing the industrial fan scale is one of a series. Some models have two scales, the second to weigh by the metric system. (10-406)

Electric Gages. General Electric Co. "21 Electric Gages to Aid Production" is an 8-page article reprint (GEA-3991). It describes their functions and has a chart showing schematic representations of gage circuit applications. Included are thickness, magnetic, electrolimit, pressure, strain and eccentricity. (10-403)

Precision Measurement. Jansson Gage Co. A 64-page handbook on this subject is devoted to the history of measurement, making gage block combinations, gage block inspection, angle measurement with the sine bar, etc. (10-402)

Surface Smoothness Tester. Brush Development Co. (10-192)

Dial Indicators. Federal Products Corp. (10-389)

pH Meters. Gamma Instrument Co. (10-334)

Electronic Micrometer. Instrument Specialties Co., Inc. (10-228)

Magnaflux. Magnaflux Corp. (10-288)

Surface-Roughness Tester. Physicists Research Co. (10-262)

Illuminated Magnifiers. E. W. Pike & Co. (10-345)

Abrasive Wear Tests. Taber Instrument Co. (10-233)

MECHANICAL TESTING

Vibration Fatigue Testing Equipment. All American Tool & Mfg. Co. (10-388)

Identifying Steel. American Tubular Elevator Co. (10-391)

Testing Equipment. Baldwin-Southwark Div. (10-121)

Physical Testing Equipment. W. C. Dillon & Co., Inc. (10-227)

Fatigue Testing Machines. Krouse Testing Machine Co. (10-201)

Tensile Testing of Fine Wire. Henry L. Scott Co. (10-55)

METALLOGRAPHIC EQUIPMENT

Metallurgical Laboratory Equipment. Adolph I. Buehler. (10-199)

Metallurgical Polishing Equipment. Tracy C. Jarrett. (10-319)

Data on Electron Microscope. R.C.A. Manufacturing Co. (10-302)

Metallographic Polishing Powder. Conrad Wolff. (10-306)

RADIOGRAPHY

X-Ray Films. Agfa Ansco. (10-315)

Protection from X-rays. Bar-Ray Products. (10-374)

X-ray Film. Eastman Kodak Co. (10-170)

Industrial X-ray Units. General Electric X-Ray Corp. (10-324)

Industrial X-ray. Kelley-Koett Mfg. Co., Inc. (10-185)

X-ray Diffraction Tubes. Machlett Laboratories. (10-300)

X-ray Tubes and Equipment. North American Philips Mfg. Co., Inc. (10-301)

X-ray Machine. Standard X-Ray Co. (10-299)

Industrial X-ray Equipment. Westinghouse Electric & Mfg. Co. (10-164)

SPECTROGRAPHY

Spectrograph Electrode Driller. Jarrell-Ash Co. (10-179)

Universal Spectrophotometers. Wilkens-Anderson Co. (10-180)

LABORATORY AIDS

Test Chambers. American Coils Co. A 2-page sheet presents low- and high-temperature chambers with humidity control, the text being confined to technical descriptions of the equipment. (10-390)

Metallurgical Laboratory Equipment. Harry W. Dietert Co. (10-50)

Salt Spray Test Equipment. Munning & Munning, Inc. (10-395)

11. General

Water Filters. R. P. Adams Co., Inc. An automatic filter for industrial plants, such as steel mills, is described by text, photos and specification tables in a 4-page folder. (11-141)

Photo Copies. American Photocopy Equipment Co. A 4-page folder describes a machine for making easily and cheaply photo copies of blue prints, drawings, photographs, letters, etc. (11-139)

Industrial Chemicals. J. T. Baker Chemical Co. This 4-page bulletin consists of a price list containing the chemicals used by the metal worker. (11-126)

High Vacuum Pumps. Beach-Russ Co. Rotary-piston pumps are described in an 8-page folder, catalog No. 75. Besides general descriptions, there are graphs on absolute pressure and a table of capacities and dimensions. (11-136)

Smoke Neutralizer. Bigelow-Liptak Corp., Div. of A. P. Green Firebrick Co. A catalog describes unit-suspended walls and arches used in flues for harmlessly carrying off acid-laden fumes, smoke and gases. (11-143)

Plant Communications. Executone Communications Systems. A 6-page pocket folder describes a two-way communication system between busy departments to free telephone extensions. (11-144)

Chemicals for the Metalworker. Glyco Products Co., Inc. This is a 112-page catalog on solvents, synthetic waxes, emulsifying agents, defoaming agents, etc. The important facts, properties and uses are listed. (11-137)

Coolers. Kramer Trenton Co. A 4-page folder sets forth the advantages of the Kramer coolant coolers for use with water, brine or direct expansion refrigerant. There are diagrams and performance tables. (11-138)

Conditioning Compressed Air. Logan Engineering Co. How to clean and dry compressed air by centrifugal force is shown in Bulletin No. 543, 8 pages, the equipment being called "Aridifier." (11-134)

Sub-Zero Refrigeration. Deepfreeze Div., Motor Products Corp. This single page mailing piece briefly describes the use of the minus 120 deg. F. freezer for shrinking metals for fits. (11-142)

Magnetic Separators and Lifting Magnets. Dings Magnetic Separator Co. (11-38)

Mercury Arc Rectifiers. General Electric Co. (11-85)

Preparing Engineering Reports. Alexander Hamilton Inst. (11-113)

Saving Air. Ingersoll-Rand Co. (11-122)

Wire Cable Lubricants. Keystone Lubricating Co. (11-131)

Vacuum Pumps. Kinney Mfg. Co. (11-112)

Gravity Conveyors. Lamson Corp. (11-129)

Acid Proof Cement. Pennsylvania Salt Mfg. Co. (11-71)

Centrifugal Blowers. Roots-Connersville Blower Corp. (11-102)

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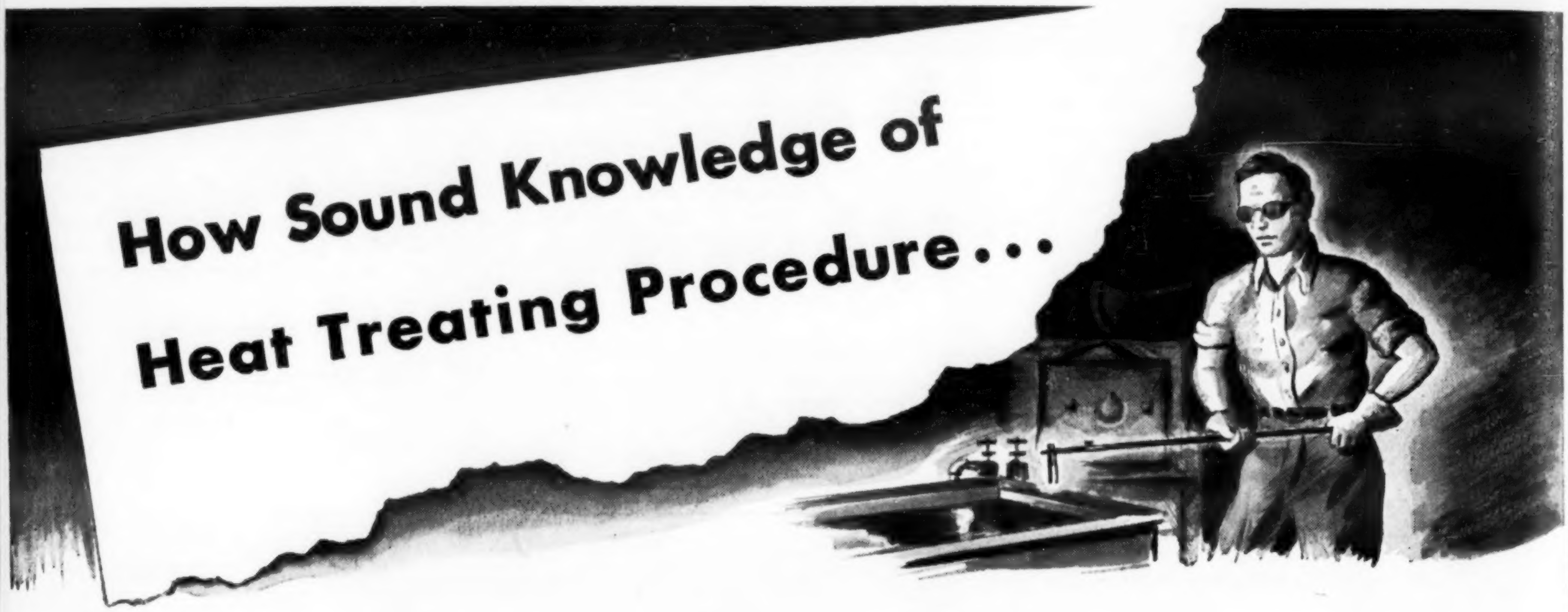
How Sound Knowledge of Heat Treating Procedure...



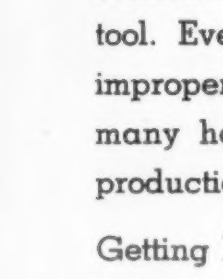
helps you avoid tool troubles that interfere with War Production

Today, with practically every tool room on 24-hour-a-day production, it is vital that tools come through heat treating intact and free from any condition that might affect the performance of the tool. Every die that lets go, every tool that is improperly hardened not only means a loss of many hours of skilled work, but is a threat to production schedules.

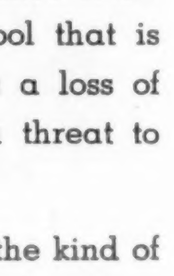
Getting hardening results that assure the kind of tools that give longer uninterrupted production is largely a matter of two things. First, having the right steel. Second, having complete heat treating data. And on each of these points, Carpenter is prepared to help you make the most of your tool making hours.

Among the nine Carpenter Matched Tool Steels, you are sure to find the steel to best meet most of your tool room requirements. And in the Carpenter Matched Set Method of tool steel selection you have a system for selecting the *one* steel that is best for each tool you make. Thousands of successful applications have proved that the Matched Set Method definitely helps to get more productive time from tools and machines.

For help in heat treating the Carpenter Matched Tool Steels, your nearby Carpenter representative will be glad to give you the benefit of his long practical experience. He can render on-the-spot service—keep you in touch with our Metallurgical Department—and supply you with literature packed with helpful information, such as that on the opposite page.



For "Refreshing" Skilled Tool Makers and Training New Men. More than 43,000 copies of this text book are now in use. Copies are available to tool steel users in the U. S. A. at cost, $1.00—$3.50 elsewhere.



For Tool Room Foremen and Tool Hardeners. A 167-page manual with a comprehensive explanation of the Matched Set Method of Tool Steel Selection, detailed heat treating data and hardening instructions. Free to tool steel users in the U. S. A.

The Standard Tool Steels of Industry

The Four Fundamental Laws of Quenching

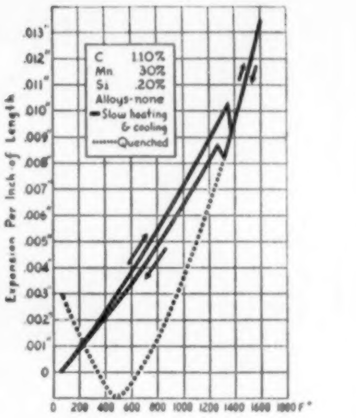
Quenching is one of the most important—and perhaps least understood steps in the heat treating operation. Anyone who has ever seen a piece of hot tool steel disappear into a quenching tank, and come out cold a few seconds later can appreciate how difficult an operation it is to study. However, when he further considers that it is at this stage that the steel hardens—and further, that warpage, size change, cracking, internal strains and soft spots are all dangers of improper quenching, he gains some idea of its importance.

There are possibilities in the quench tank that the hardener does not always realize. It is common knowledge that quenching produces *internal strains* in a piece of steel—forces that are sometimes powerful enough to smash a piece of hardened steel whose strength may measure close to 400,000 lbs. per sq. in. If forces of this magnitude can be developed in quenching, it is worthwhile to devote some effort to making them *useful* instead of destructive. Here are the four fundamental laws of quenching:

LAW NO. 1—*Steel is stronger cold than hot.* Everyone knows that steel is easier to bend, shape or deform when it is hot. Therefore, when hot steel comes into conflict with cold steel, the cold steel always wins. *(This law explains why a steel rod quenched horizontally will warp upward at the ends.)*

LAW NO. 2—*Steel expands when heated and contracts when cooled.* This is illustrated by the solid curve in the chart, which shows the behavior of a piece of high carbon tool steel heated and cooled slowly in a furnace. Starting at room temperature, the steel gradually expands up to about 1350°F. when it will be about .010″ longer per inch than it was when it started. Here, it reaches the critical point, and while going through the critical, it shrinks somewhat. Above the critical, it continues to expand at a more rapid rate.

On cooling slowly, it shrinks until it reaches about 1310°F. expands while going through the critical and then shrinks back to its original size as room temperature is reached. *(The importance of this law is obvious—since, if different parts of a tool are not cooling at the same rate, stresses will be set up in proportion to the difference in cooling rates.)*



LAW NO. 3—*Some tool steels increase in volume when hardened.* This is particularly true of water-hardening tool steels. They actually increase in size all over—just as water expands when it freezes. The dotted line in the chart shows the approximate course through which carbon tool steel would travel if it were quenched instead of being cooled slowly. It would continue to shrink (without any critical point interruption) to some temperature in the neighborhood of 500°F. As it cooled below this temperature, it would expand until it would finally be about .003″ per inch longer than it was when it started in the annealed condition. *(This law explains why some tools change size in hardening and why some break in the quenching bath. Size change as such is not necessarily disastrous, but if the volume change in part of the tool differs greatly from that in an adjacent part, cracking may result.)*

LAW NO. 4—*All steels when stressed under the elastic limit have the same elastic properties—regardless of composition or heat treatment.* This may seem impossible, but it is true nevertheless and has been demonstrated many times. All steel, *regardless of its analysis or heat treatment* will stretch exactly .001″ per inch under a load of 30,000 lbs. per sq. in. *(This law makes possible the measurement of internal stresses in a piece of quenched tool steel, by simply measuring the amount of distortion. By such a study it is possible to obtain information to control the quenching operation so as to minimize warpage and breakage.)*

Much helpful information on quenching, like that above, is contained in "Tool Steel Simplified". It is only a small part of the hundreds of pages of practical information on every phase of tool making given in the book. You can put *all* its useful facts to work in your tool room by making copies available to your tool room men. "Tool Steel Simplified" is available *at cost*—$1.00—in the U. S. A.

The Carpenter Steel Company, 135 Bern Street, Reading, Pa.

Carpenter MATCHED TOOL STEELS

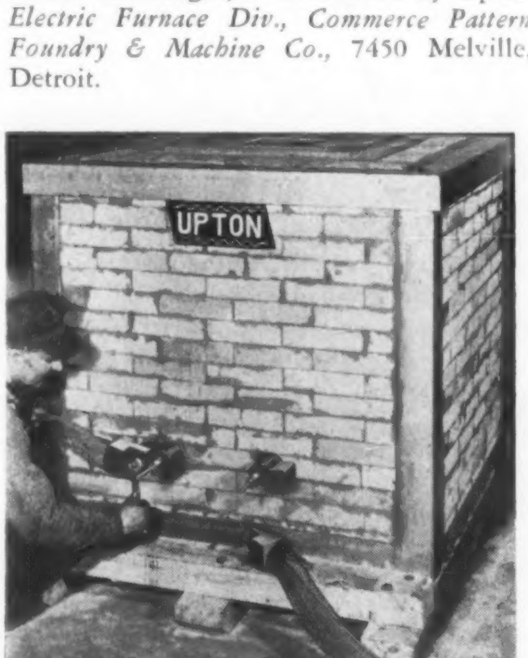
BRANCHES AT Chicago, Cleveland, Detroit, Hartford, St. Louis, Indianapolis, New York, Philadelphia

METALLURGICAL ENGINEERING news

Equipment • Finishes • Materials • Methods • Processes • Products
Alloys • Applications • Designs • People • Plants • Societies

New Electric Salt Bath Furnaces

A revolutionary advance in the design and manufacture of internally-heated electric salt bath furnaces, which eliminates the need of changing electrodes, improves efficiency, and permits hardening of tools of extreme length, is announced by *Upton Electric Furnace Div., Commerce Pattern Foundry & Machine Co.,* 7450 Melville, Detroit.



It is impossible for work to be burned, starting is faster, hold-over is cheaper, and small production treating of small tools is more uniform, accurate and cheaper. There is positive and uniform circulation of salt throughout the bath.

Called the "Sealed-Electrode" design, its success lies in the method of sealing the electrodes through the sides of the furnace so that the electrodes can be located beneath the surface of the salt or at the extreme bottom of the pot, with none of the heated portion exposed to the air.

The only portions air-exposed are cooled by circulating water and held at body temperature, hence with no oxidation. The furnace can be built to any reasonable depth without any increase in the area being required. Thus, a furnace was built 37 in. deep, with area of 9 x 9 in. Tools of extreme length, such as saw blades, broaches, etc., can be suspended vertically.

Between 1200 and 2500 deg. F. they can be used with Upton heat measuring control. Pots are ceramics. Furnaces can be operated on merely enough salt to heat the tools, with only 5 in. of salt needed to hold the furnaces over. Only 3 in. is ample for starting.

In the photograph, electrodes are shown with transformer leads and cooling water inlet and overflow connections.

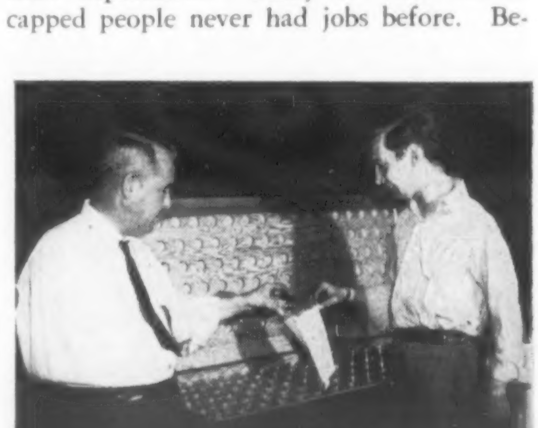
Unique Rivet Control System

Employment of physically-handicapped workers to control all handling of warplane rivets has caused a tremendous slash in salvage operations at the Columbus plant of *Curtiss-Wright Corp.* The method has reduced to 4 per cent the number of rivets going into salvage operations. Tons of rivets are handled. Thus, 125,000 are installed in each Helldiver.

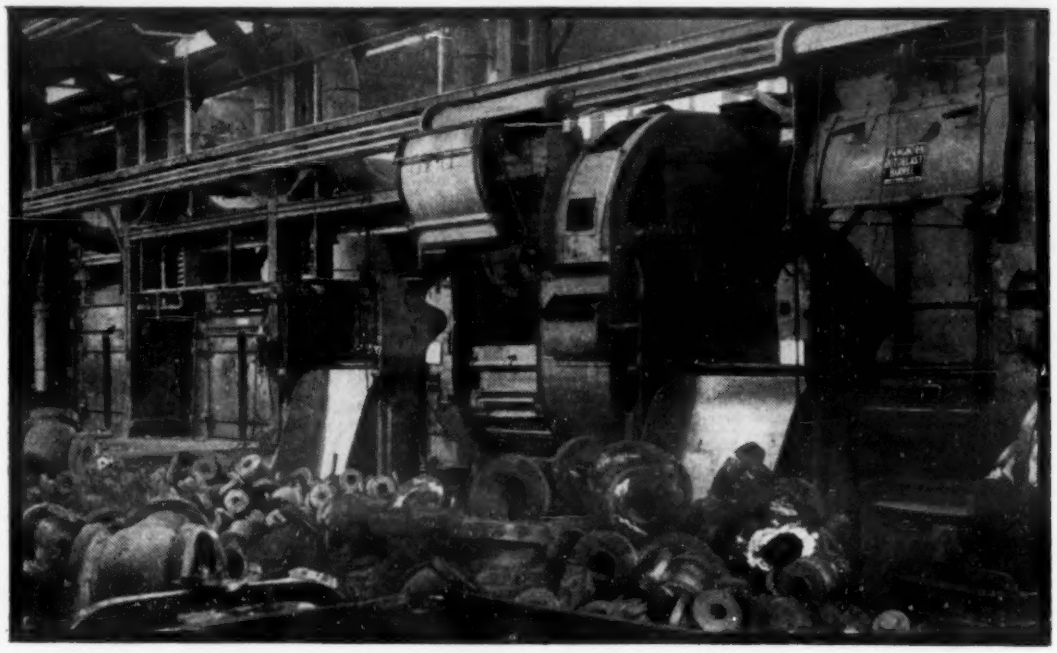
They sort rivets of 1900 different lengths and sizes, supervise departmental rivet refrigerators, and keep workers' individual portable ice boxes supplied with dry ice. They pass out the proper number from ice boxes.

When workers previously helped themselves they took too many out at a time, the rivets warming up and becoming too age-hardened to be driven without cracking. Previously, too, ice boxes were not kept at the correct temperature, hence "spoiled."

They sort rivets that have become hot and hard and return them to the heat-treat department. Many of these handicapped people never had jobs before. Because of the confidence gained, several have risen to higher positions.



In the accompanying photograph are two handicapped workers, preparing a bag of sorted rivets for delivery to the heat-treat department. In one case it is the loss of the right arm; in another, a crippled left hand.



D.C. Welder Calibration Plate

A new d.c. welder calibration plate to give exactly the right heat across the arc for each electrode is announced by *Harnischfeger Corp.*, 4400 W. National Ave., Milwaukee. Called the "Visi-Matic," it provides for all variables of amperage and voltage coincident to using today's wide range of coated electrodes, and by its single current control reduces proper selection of welding current to the simplest form.

Calibrated in amperes, it can be used with any make of electrode. Compensation

for variations in voltage with the amount of current or amperes, as required by variations in electrode coatings, is attained by merely turning the one current indicator to the amperage setting desired in either the low-, medium- or high-voltage band.

Individual color bands designate the voltage ranges. All P & H d.c. welders are now being equipped with "Visi-Matic."

● A simple change in the design of a "Tocco" induction fixture has made possible a rapid "3-in-1" heat-treat operation on diesel engines for army tanks, states A. O. Wood, chief engineer, Tocco Div., *Ohio Crankshaft Co.*, Cleveland. On engine balancer shafts, induction treatment hardens a bearing surface and a thrust face while brazing a collar to the shaft, all done simultaneously in 41 seconds.

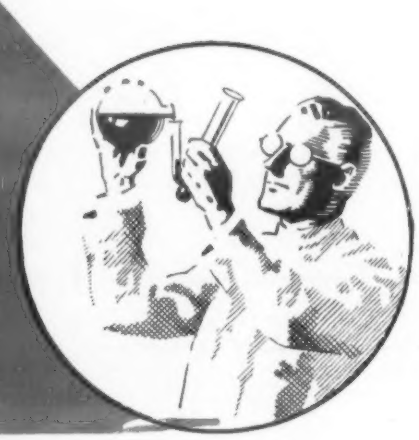
Two Sizes of Electronic Heaters

A line of electronic heaters for high-frequency induction heating of metal parts for brazing, soldering and selective heat treating is announced by the *Industrial Heating Div., General Electric Co.*, Schenectady. They are power oscillators that convert 60-cycle power to high-frequency power at 500,000 cycles, one size having a 5 kw. output, the other 15 kw. Tubes have a life expectancy of 5000 to 10,000 hrs.

Among their advantages are: Heating is rapid and confined to the desired area; work can be carried on by unskilled operators after preliminary adjustments have been made; the amount and distribution of heat are controlled accurately and automatically; and critical alloy steels can be conserved.

It takes
CHROME PLATING
to protect the surface

and
Laboratory Control
TO INSURE GOOD
Chrome Plating



ENGINEERING is fast accepting chrome plating as the "order of the day," in many of America's largest war production plants.

Worn or mis-machined tools, material and equipment are being salvaged instead of scrapped. A multitude of vital parts in planes, tanks, ships and communications equipment, subject to continuous wear and corrosion are being surface-protected by hard chrome plating.

CONSULT CUMMINS ON YOUR PLATING PROBLEMS

To meet the exacting specifications and required uniformity so vital in all your plating work, Cummins' method of LABORATORY CONTROL assures you of rapid, reliable results. Our LABORATORY CONTROL method pre-determines the plating procedure on each job, thus reducing to a minimum any possibility of "rejects" and "do-overs."

Through our LABORATORY CONTROL method, successful plating operation is assured through the proper coordination of chemicals and processes. It is this scientific approach to your plating work that makes the *big* difference between *knowing-how* and *experimentation*.

Our modern plants and facilities can service your plating requirements on tools, gauges, dies, etc., as well as plating needs in the electronic field.

Licensee, United Chromium, Inc.

GILBERT
CUMMINS
AND COMPANY

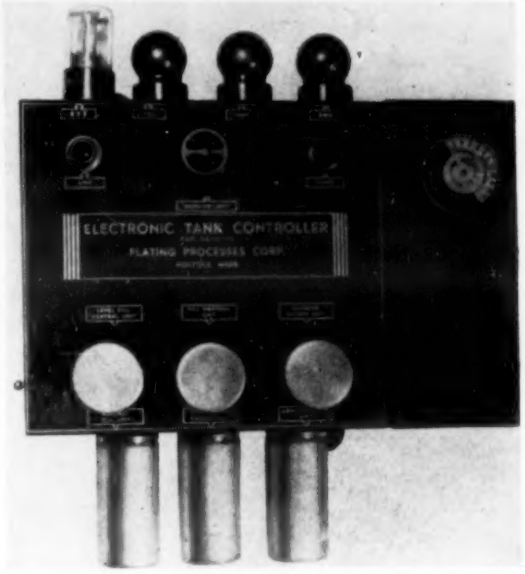
Laboratory Controlled INDUSTRIAL ELECTROPLATING

Executive Offices: 505 WATER STREET, BALTIMORE-2, MD.

Plants: 2800-02 Frederick Ave., and 505 Water St., Baltimore, Md.

Automatic Plating Tank Controller

A new automatic tank controller for platers and metal finishers has been brought out by *Plating Processes Corp.*, Holyoke, Mass. It automatically maintains a predetermined solution level, controlling tem-



perature whether the solution tends to heat or cool.

It is based on a new principle that uses a copper inexpensive thermostatic bulb for all types of solutions, assuring long life of equipment.

It gives warning signals at the tank and in the watchman's station, and provides automatic starting and stopping. It was given severe tests before being brought upon the market.

● To meet the requirements and specifications of the Government for protection of all metal parts while in storage or in shipment overseas, "Carbozite Overseas Shop Coat" has been introduced commercially by *Carbozite Corp.*, 1001 First National Bank Bldg., Pittsburgh. It can be applied by brush, dip or spray and dries from 15 to 30 min. It is removed easily by naphthas when destination is reached.

Metal Plating on Plastics and Glass

A new process by which plastics, glass, or any non-conductor are plated with any of the plating metals is announced by *Precision Paper Tube Co., Special Products Div.*, 2023 W. Charleston St., Chicago 47. The sponsors claim that the plating goes on the plastics as perfectly and permanently as the best in any plated metal.

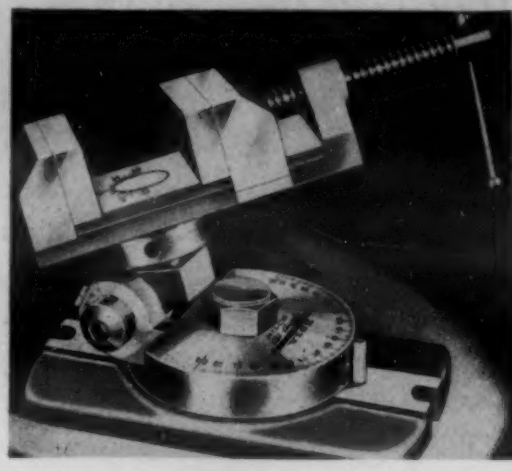
Convex and concave surfaces, convolutions, corners and recesses are as thoroughly plated as flat or simple round surfaces. It does not crack, chip or peel off in severe service.

Advantages claimed are: Critical and strategic metals are conserved, costs are reduced, weight is saved, design can be simplified, dimensional stability is insured. Moreover, oils, solvents and moisture cannot be absorbed. Electrolytic corrosion between dissimilar metals is eliminated, and heat resistance is increased.

It can be used for plating magnetic and electric shielding of all kinds. Both rigid and pliable types of plastic tubing and pipe fittings can be plated.

Drive Wheel Movement Vise

An all-angle "Drive-Wheel movement" vise with three accurate and legible protractor dials for horizontal, vertical and diagonal settings is announced by the *Berco Mfg. Co.,* 429 W. Superior St., Chicago. It is recommended for grinders, drill



presses, milling machines, magnetic chucks, cutter-grinders and many other machine tools.

Its many features include a patented drive wheel motion that gives a 2¾ in. lateral clearance; double swivel construction, which permits any conceivable horizontal position; right angle clearance, which allows perpendicular position without base obstruction; positive horizontal setting for highest 180 deg. accuracy; elimination of excess weight; and improved construction, resulting in easy handling by men or women workers.

● A list of fluxes, known as A.B.C. Foundrates, is being manufactured by the *American British Chemical Supplies, Inc.,* 180 Madison Ave., New York. They are purifying metals and removing dross, are deoxidizing iron and steel melts, improving fluidity and removing the gas; keeping tin and zinc in the metal that formerly went up the stack; and reclaiming aluminum turnings, borings, grindings and skimmings.

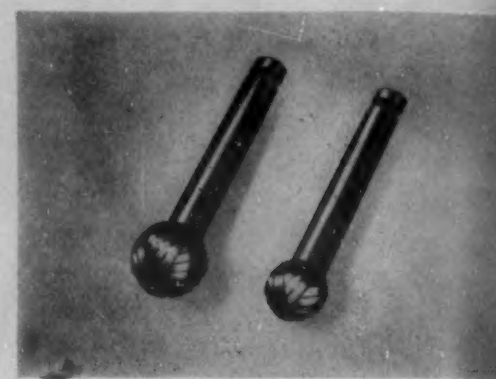
Pressure Joint for Internal Machining

When machining the inside surfaces of internally-cored castings or steel stock, it is sometimes difficult to provide cutting oil or coolant where the cutting takes place. By means of a special rotary pressure joint, made by *Johnson Corp.,* Three Rivers, Mich., the oil is admitted inside the spindle of the turret lathe, passing through the spindle directly to the tools at the working end. It also washes away most of the cuttings and turnings. It is suitable for other machines handling similar operations.

This pressure joint is a completely packless type of stuffing box or steam fit, and has been used for many years in paper making and textiles, and more recently in the manufacture of synthetic rubber. Two carbon graphite rings of special composition eliminate any need for packing, and are self-lubricating. Pressure itself within the joint becomes the sealing force.

Cemented-Carbide Burring Tools

The first cemented-carbide burring tools (rotary files) ever to be produced are announced by *Carbur, Inc.*, Lincoln Park 25, Mich. They have cutting teeth that are ground from the solid on special machines.



The cemented-carbide heads are securely attached to the steel shanks by a new process.

Tests show they provide at least 50 times the tool life of high-speed burring tools, while an aircraft engine manufacturer claims 100 times longer than steel burring tools used on cylinder heads and crankcases. They speed and make more efficient burring operations, less replacement is needed, and tool sharpening is reduced.

They are supplied only in ball-end types in 3/8 and 1/2 in. sizes (ball end diameters). Shanks are 0.250 in. in diam., and burring tools are 2 1/2 in. over-all.

● New Grayson-Kennametal milling cutters are constructed with sturdy bodies of Meehanite tipped with Kennametal. Shock-resistance of the body is combined with the hardness and strength of Kennametal to produce a rugged tool for rapid face, side, end, slot and straddle milling. Cutters with double negative rake angles are available in grade KM for milling steel, with positive rake angles in grade K2S for rough milling of cast iron or K4H for aluminum-silicon alloys, magnesium-aluminum alloys, brass, bronze, etc.

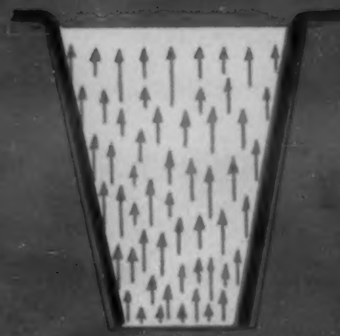
Magnetic Clamp for Welded Members

The Sweetland magnetic clamp for positioning welded members, designed for shipyards but applicable elsewhere, is announced by *Glenn-Roberts Co.*, 1009 Fruitvale Ave., Oakland, Calif. The clamp is of compact, light-weight construction. It is equipped with retractable ball-bearing wheels on a ball-bearing swivel.

With it, tack welds are made directly, without the use of saddles, clips or other means requiring temporary welds. This cuts time two-thirds, does away with chipping, eliminates saddles, yokes, etc., and avoids setting up stresses from temporary welds.

For fairing deck plates, one magnet is placed across the seam to bring plates to the same level. With warped plates, a single magnet, used with a Johnson bar, quickly effects leveling.

This Simple Principle of Design



Plus this Fool-Proof Heat Control

Guarantees that this Upton Electric Salt Bath Furnace

Will Harden this Hob so Accurately and Uniformly

that it Will Not Require Finish Grinding!

Commercial Heat Treaters Do Better Work with *UPTON Electric Salt Bath Furnaces*

The three principal problems of commercial heat treaters are all solved with Upton Electric Salt Bath Furnaces and Upton heat measuring controls.

Inexperienced help can now be quickly trained in the use of the Upton Heat Measuring Control to get perfect results, *all the time*. It tells when the work is done. It even signals him when he has made an error in timing adjustment.

Moly steels are easily handled with the Upton Electric Salt Bath Furnace. *During* heating the entire tool is safely submerged in the salt. *After* the tool is removed, the salt still coats the surface and prevents oxidation.

Predictable size change is so exact—with Upton Electric Salt Bath Furnaces and the Upton Heat Measuring Control—that finish grinding is entirely eliminated on many tools—the same kind of tools that formerly required finish grinding.

Electrodes for heating the salt in the pot are usually placed in the diagonally opposite corners of the pot—out of the working area. These electrodes can be changed in a few minutes, without special equipment and are usually of low cost mild steel.

The greatest amount of heat is generated within the salt near the bottom of the pot. The heated salt can then rise normally, naturally and circulate throughout the entire bath. (The proof of this is the absolute uniformity of work—the absence of distortion in special tools of large size.)

Upton Electric Salt Bath Furnaces are available for inspection in Detroit under actual *Commercial* heat treating conditions. Ask for complete information now. (To save time, why not give us a description of the work to be handled?)

Upton ELECTRIC FURNACE DIV.

UPTON Electric Salt Bath Furnaces are available for all types of Heat Treating from 300° to 2500° F.

MELVILLE AT GREEN DETROIT, MICHIGAN

News of Men, Societies, Meetings and Companies

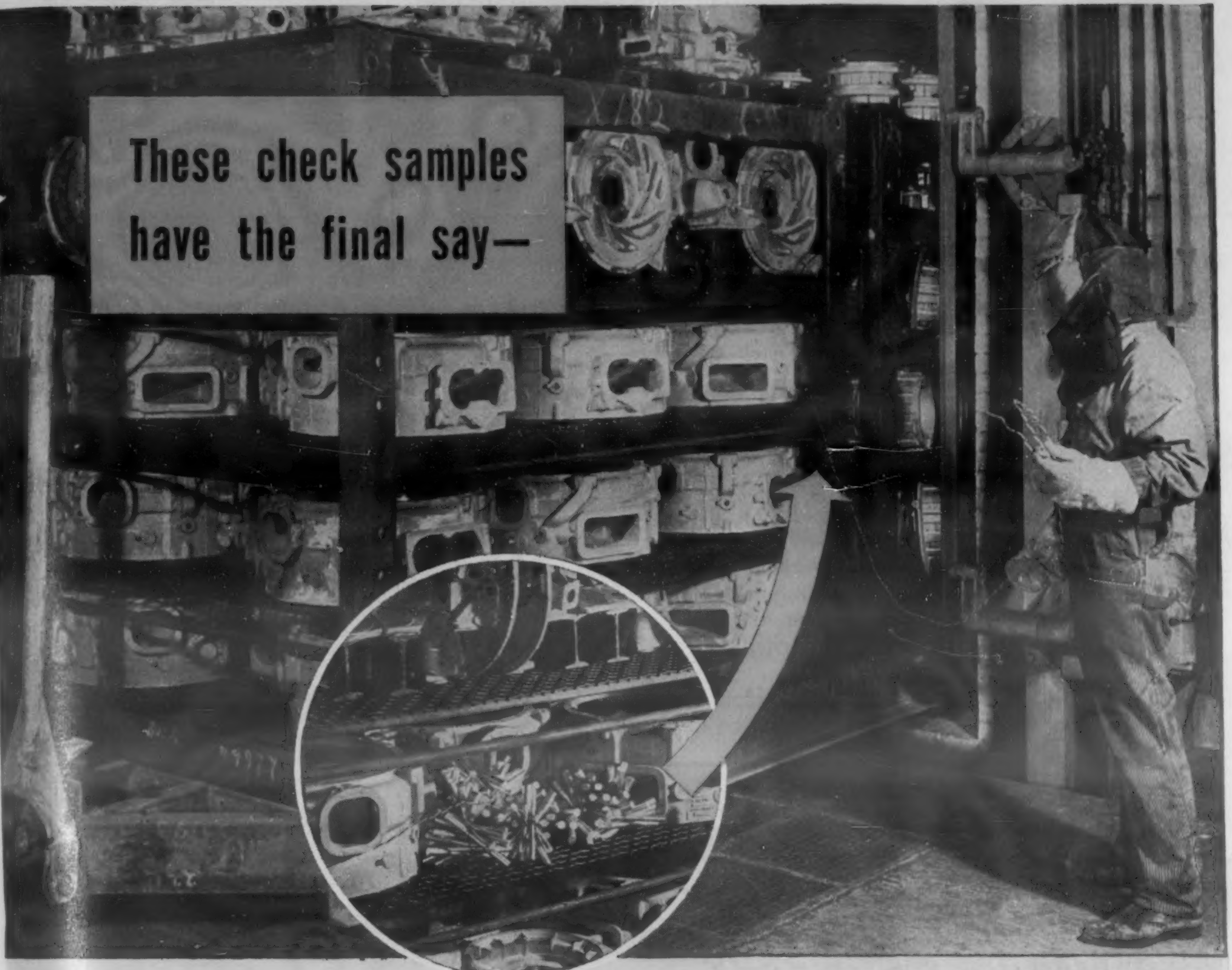
Plants and Slants

Speaking of women — and who doesn't at times? — *Archer & Smith, Ltd.* (formerly Hub Tool Co.), Lexington, Ky. report that women are superior workers in their production of precision cutting tools. Under direction of highly-skilled men, practically all operating employees are women. Production men, engineers, draftsmen, superintendents, foremen and setup men are selected men of exceptional skill and experience.

Its 70th Anniversary was celebrated in June by *S. G. Taylor Chain Co.*, Hammond, Ind., makers of load and sling chains for all industrial purposes, as well as tire chains. Members of one family have been in continuous and active management of the company all these years. E. Winthrop Taylor, president, is grandson of the founder.

The name of the *York Ice Machinery Corp.* has been changed to *York Corp.*, following a merger with a subsidiary, the *York Corp.*

Old industrial ties between the *Cooper-Bessemer Corp.* and 600 former workers in armed services are kept fresh by a thoughtful ingenious plan. In a carefully compiled card-index filing system at the company's Mt. Vernon headquarters, the name, rank, address and birth date of each employee in the armed services is recorded and kept up-to-date. Birthday greetings



SO MUCH depends upon the heat treatment given magnesium castings!

In American Magnesium foundries they recognize this fact to the extent that all charges going into the furnaces carry test bars representing each batch heat treated. It's not enough to trust to skilled workmen employing practices backed by more than twenty years experience, accurately controlled temperatures and protective atmospheres in the furnaces. Those checking samples must test "O. K." before the castings are approved for shipment.

Structural properties . . . toughness, yield strength and hardness . . . are improved by proper heat treatment. Castings supplied to you by American Magnesium Corporation are heat treated *right*. Your products have the lightness which magnesium alloys give them, plus Mazlo dependability.

American Magnesium Corporation pioneered in controlled atmosphere heat treating for magnesium, starting in 1926. Today, all our furnaces carry an atmosphere of dry sulphur dioxide as protection for casting surfaces . . another example of the constant drive for higher quality by the makers of Mazlo Magnesium Products. Sales Agent: Aluminum Company of America, 1710 Gulf Building, Pittsburgh, Pa.

MAGNESIUM MAZLO PRODUCTS

REG. U.S. PAT. OFF.

AMERICAN MAGNESIUM
CORPORATION

SUBSIDIARY OF ALUMINUM COMPANY OF AMERICA

are mailed to each in the form of a cheerful, 3-color folder bearing a hand-written personal message from B. B. Williams, chairman of the board. Those within the U. S. receive a carton of cigarettes, and those overseas some other gift. Besides, each receives monthly the "C-B News." The popularity of the program is attested by scores of grateful letters.

Metallurgical laboratories that were established by Sam Tour during the 14 years he has been vice president and chemical and metallurgical engineer, in charge of engineering departments of *Lucius Pitkin, Inc.*, now located at 45 Fulton St., New York 7, are now operated as the laboratories of *Sam Tour & Co., Inc.*, with main offices at 65 Pine St., New York. Lucius Pitkin, Inc. will continue as before as analists, assayers, etc., with main offices and laboratories at 47 Fulton St., New York.

United States Steel Supply Co., U. S. Steel subsidiary, has bought the physical assets of *Moise Steel Co.*, Milwaukee.

Ilg Electric Ventilating Co., 2859 N. Crawford Ave., Chicago, will build a new research laboratory building immediately west of the present plant. Equipment will include latest scientific instruments for measuring air, electricity, sound, light and vibration.

McCulloch Engineering Corp., Milwaukee, maker of superchargers, has been acquired through cash purchase of all of the stock by *Borg-Warner Corp.*, Chicago.

H. K. Porter Co., Inc., Pittsburgh, has purchased the *Quimby Pump Co.*, with plants at Newark and New Brunswick, N. J.

A new blast furnace was blown in June 18 at the Lackawanna plant, *Bethlehem Steel Co.*, with a rated daily capacity of 1200 tons of pig iron.

Lycoming Div., Aviation Corp., has set up a new $500,000 plant at S. Williamsport, Pa., to take care of Lycoming's subcontracting work.

Follansbee Steel Corp. has installed a 14-in. roughing and a 12-in. finishing merchant mill for the rolling of alloy and tool steel rounds, squares, hexagons, octagons and flats.

Briefs on Associations, Promotions, Education

The 25th annual National Metal Congress will be tailored to war conditions. Instead of a grand exhibition in some large public hall, War Conference Displays will be held in special rooms in the Palmer House, Chicago, the week of Oct. 18, 1943. These rooms will accommodate light equipment and metal parts. Manufacturers are being urged to use models, moving pictures, photographs and literature to present new developments to the industry. The entire congress "will be turned to the increase of war production

in the metal industry, conservation of metals and post-war planning." Technical sessions will be streamlined and comprehensive. Participating societies will be American Society for Metals, American Welding Society, Wire Assn., and Iron, Steel and Metals Divs. of the American Institute of Mining and Metallurgical Engineers.

What is claimed to be the first national convention ever held by radio will take place in September, that of the National Association of Foremen, designed to patriotically save railroad transportation. The network program will be limited to one hour, with speakers of national prominence discussing questions of universal interest to American industry. Throughout the country member clubs will hold local meetings at which they will listen to the national broadcast, then proceed with localized discussions by various key men.

Dean Harvey, Westinghouse materials engineer, was elected president of the American Society for Testing Materials at the annual meeting at Pittsburgh in late June. He succeeds H. J. Ball, professor of textile engineering at Lowell (Mass.) Textile Institute. Mr. Harvey has been a materials specialist with Westinghouse over 30 years, and more recently has been chief, Conservation Div., WPB. John R. Townsend, material standards engineer, Bell Telephone Laboratories, Inc., New York, became vice president.

High school boys of 16 and 17 alternate two weeks in the shops and two weeks in high school, through arrangements made by Westinghouse Transformer Div., Sharon, Pa. They earn while they learn to become machinists, journeymen, tool and die makers, and draftsmen.

There is a new type of engineer, the "human" engineer, states Rear Admiral C. H. Woodward, U.S.N. (Ret.) chief of the Industrial Incentive Div., Navy Dept. His job is stimulating the interest of workers. He surveys the situation in each department of the plant, discovers the incentive problems, and prescribes the appropriate remedies. If efficient, he can contribute as much to production as any other engineer of the more established professions.

Heat prostrations in steel plants during the record-breaking heat wave in early summer were reduced to an all-time minimum through the effects of medical science and modern management methods, states American Iron and Steel Institute. Many large plants reported no heat cramps nor prostrations. Chiefly responsible has been the widespread use of salt tablets furnished by steel companies. Other reasons are better eating habits and shorter working hours.

Another plant is "sold" on women workers — Northern Aircraft, Products Div., Aviation Corp., Toledo, Ohio. Henceforth, women exclusively will be hired for production work. The company makes precision aircraft engine and propeller parts. Men are employed solely as job setters, supervisors and instructors.


NEED ANY HELP...
SUMMARY OF DATA ON RUSTLESS STAINLESS STEELS
RUSTLESS IRON AND STEEL CORPORATION
BALTIMORE • MARYLAND
ON *Selection* OF STAINLESS STEEL?
WHEN YOU WANT TO KNOW ABOUT STAINLESS...

News of Engineers

Robert L. Coe, vice president, Chase Brass & Copper Co., Inc., has been re-elected president of the Copper & Brass Research Assn. Theodore E. Veltfort was re-elected manager and Bertram B. Caddle, secretary.

"The cost of metals will go down sharply after the war, making possible their use to an extent undreamed of in the past," stated B. W. Clark, vice president in charge of sales, Westinghouse, to the Electric League of Indianapolis.

William J. McMillen has been made manager of production and manufacturing of Mackintosh-Hemphill Co., Pittsburgh, having been assistant manager of roll sales. He started with that company 26 years ago as assistant in the physical testing laboratory.

E. G. de Coriolis, research director, Surface Combustion Div., General Properties Co., Inc., Toledo, Ohio, was given honorable mention by the National Metal Trades Assn. for his development of the RX gas generator, which has effected substantial savings of critical alloys used in industrial furnaces and heat treat processes.

William P. Woodside has resigned as vice president in charge of research of the Climax Molybdenum Co., having spent the past half century in the steel industry. He joined Climax in 1926, was responsible for the formation of the research laboratory in 1931, and did much to make molybdenum a prominent metal. *Alvin J. Herzig,* chief metallurgist for Climax, will take over Mr. Woodside's duties.

Wilbur R. Varney has resigned as metallurgist and department superintendent of Taylor-Wharton Iron & Steel Co., Easton, Pa., to become a lieutenant in the Naval Reserve. For the past two years he has been instructor of metallurgy and metallography at Lafayette College Engineering, Science and Management War Training program.

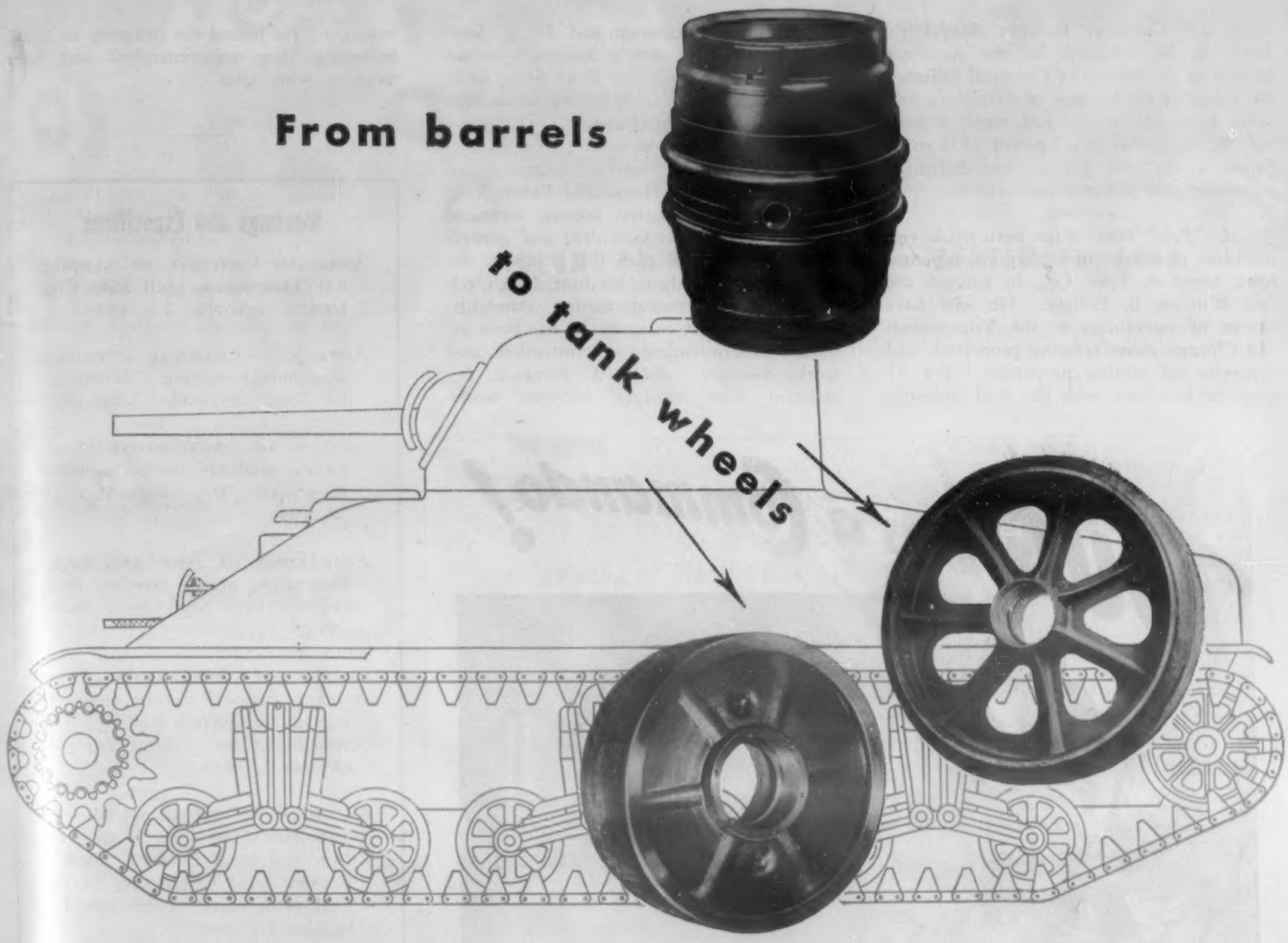
John E. Mateer has been appointed superintendent of the open-hearth department of Lukens Steel Co., Coatesville, Pa., having previously been assistant. He succeeds *Herman J. Hofmann,* who resigned because of ill health. Mr. Mateer started his steel worker career in 1907 as a door boy in Luken's open-hearth. He worked up to assistant superintendent in July, 1940. Mr. Hofmann had worked also for both what is now Carnegie-Illinois and Donner Steel Companies.

George M. Muschamp and *Paul L. Goldstrohm* have been made vice presidents of the Brown Instrument Co., Philadelphia. The former will have charge of engineering, and the latter of production. Mr. Muschamp directed development of several electronic devices, including the potentiometer for controlling industrial temperatures.

Ernest Muller has been appointed assistant to Mark A. Follansbee, vice president in charge of sales, Follansbee Steel Corp., Pittsburgh, and will devote major efforts to post-war objectives. He majored in metallurgy at Sheffield Scientific School, and has been engaged in research for the U. S. Steel Corp. of Delaware.

Joseph L. Mullin has been made general superintendent of foundries, American Manganese Steel Div., American Brake Shoe Co. He had been works manager at the New Castle, Del., plant but will hereafter be at Chicago Heights, Ill. He was employed in 1914 by the then Edgar Allen Manganese Steel Co., as clerk in the annealing department. *W. F. Kelly,* plant superintendent at New Castle, succeeds Mr. Mullin, having joined the company in 1925.

Dr. John J. Grebe, director, physical research laboratory, Dow Chemical Co., Midland, Mich., has been elected to re-



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ceive the Chemical Industry Medal for 1943, to be awarded by the American Section of the Society of Chemical Industry. He invented the method of extracting bromine from sea water, and more recently led the successful development of styrene, Saran, a synthetic plastic, and butadiene monomer and polymer production.

J. L. "Pete" Mauthe has been made vice president in charge of operations, Youngstown Sheet & Tube Co., to succeed the late William B. Gillies. He will have charge of operations at the Youngstown and Chicago manufacturing properties, and supervise all mining properties. For 31 years he has been with the steel industry, both with Youngstown and U. S. Steel subsidiaries. He was a nationally-known football player with the Penn State team, which he captained in 1912. He is succeeded by *Albert S. Glossbrenner*.

E. A. Koether, works manager since 1936 of American Hammered Piston Ring Div., Koppers Co., has become technical assistant to the vice president and general manager, and will plan for post-war, developing new products, machine design, job methods and manufacturing standards. With his present company he has been assistant superintendent, superintendent and works manager. *Edgar S. Freeman, Jr.*, assistant sales manager, becomes works manager. He joined the company in 1920, becoming shop superintendent and later working with sales.

Meetings and Expositions

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. Salt Lake City, Utah. September 2-4, 1943.

AMERICAN CHEMICAL SOCIETY, semi-annual meeting. Minneapolis, Minn. September 6-10, 1943.

SOCIETY OF AUTOMOTIVE ENGINEERS, national tractor meeting. Milwaukee, Wis. September 23-24, 1943.

ASSOCIATION OF IRON AND STEEL ENGINEERS, annual meeting. Pittsburgh, Pa. September 28-30, 1943.

SOCIETY OF AUTOMOTIVE ENGINEERS, national aircraft engineering and production meeting. Los Angeles, Calif. September 30-October 2, 1943.

AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS, Iron and Steel Division, Electric Furnace Steel Committee, 1st annual conference. Pittsburgh, Pa. October 1-2, 1943.

ELECTROCHEMICAL SOCIETY, annual convention. New York, N. Y. October 13-16, 1943.

AMERICAN INSTITUTE OF MINING & METALLURGICAL ENGINEERS, Regional meeting: Inst. of Metals and Iron & Steel Divisions. Chicago, Ill. October 16-19, 1943.

AMERICAN SOCIETY FOR METALS, annual convention. Chicago, Ill. October 18-22, 1943.

AMERICAN WELDING SOCIETY, annual meeting. Chicago, Ill. October 18-22, 1943.

AMERICAN INSTITUTE OF MINING & METALLURGICAL ENGINEERS, Petroleum Div., fall meeting. Los Angeles, Calif. October 21-22, 1943.

AMERICAN INSTITUTE OF MINING & METALLURGICAL ENGINEERS, Industrial Minerals Div., fall meeting. Wilmington, Del. October 21-23, 1943.

AMERICAN INSTITUTE OF MINING & METALLURGICAL ENGINEERS — AMERICAN SOCIETY OF MINING & METALLURGICAL ENGINEERS, joint fuels conference. Pittsburgh, Pa. October 28-29, 1943.